OUTLINE OF NATURE
IN THE BRITISH ISLES

VOLUME ONE

2035

OUTLINE OF NATURE
IN THE BRITISH ISLES

VOLUME 1

BRITISH BIRDS' EGGS OF CHASTE BEAUTY AND DELICATE SHAPE

Above are represented in their actual colours and slightly reduced in size the eggs of fifty of the birds described under the heading "Our Birds and Their Eggs."

1 Lapwing. 2 Blackbird. 3 Wren. 4 Green woodpecker. 5 Whitethroat. 6 Song thrush. 7 Golden plover. 8 Partridge. 9 Goldfinch. 10 Pied wagtail. 11 Lesser redpoll. 12 Red-backed shrike. 13 Whinchat. 14 Marsh warbler. 15 Swallow. 16 Magpie. 17 Nightingale. 18 Spotted flycatcher. 19 Red grouse. 20 Robin. 21 Tree pipit. 22 Rook. 23 Chiffchaff. 24 Kestrel. 25 Carrion crow. 26 Blackcap. 27 Jackdaw. 28 Great tit. 29 Bullfinch. 30 Pheasant. 31 Hedge sparrow. 32 Blue tit. 33 Sparrow-hawk. 34 Common bunting. 35 Reed warbler. 36 Kingfisher. 37 Chaffinch. 38 Yellow-hammer. 39 Barn owl. 40 Skylark. 41 Jay. 42 Missel thrush. 43 Linnet. 44 Stonechat. 45 Cuckoo. 46 Raven 47 Nightjar. 48 Golden eagle. 49 Starling. 50 Peregrine falcon.

OUTLINE
OF
NATURE

IN THE BRITISH ISLES

A Comprehensive Photo-Survey of the Varied Life of Field and Hedgerow, Moor and Mountain, River, Pond, and Sea

SIR JOHN HAMMERTON
EDITOR

With 17 Colour Plates, 136 Plates in Photogravure, and about 3,000 other Illustrations

VOLUME I
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The Editor's Foreword

GENERATIONS of town and city dwelling have failed to turn us into a wholly urban people. More true is it to say that even as man has become more urbanised, so has his interest increased in the countryside and its natural wonders. From the time when the Industrial Revolution began to herd the bulk of Britain's population into towns, there have, for example, always been rambling clubs and other forms of response to the urgent human need of keeping, so to speak, one foot in the countryside of our forefathers. Living within a frame of concrete and steel, bricks and mortar, has instilled in the townsman a feeling that he is the prisoner of his own inventions. Whenever opportunity arises he seeks his lost freedom in the unspoiled byways of the countryside. There, the flight of a bird above him, the hum of a bee flitting from flower to flower, and the gentle rustle of a tree, bring the comforting reflection that in a world of change and unrest the most fundamental things remain stable. He is instinctively aware that in the appreciation of nature and the desire to learn more of her eternal ways lie real refreshment and recreation of body and spirit.

YES, most of us are naturalists at heart; though in varying degree. There are three kinds of naturalist. There is first the specialist, the man who devotes his time to the intensive study of one particular branch of nature, be it trees or plants, animals or insects, fish or shells, or the mysteries of rock formation. Then there is the general student, who takes the whole realm of nature, but thinks in terms of species and families. Finally there is that vast body of ordinary folk who, fascinated by a skimming butterfly, spotted eggs in a hedgerow nest, some timid unrecognised animal in the undergrowth, the budding of a flower in spring, or the glory of a sunset, would like to know more and more about the wonderland of field and hedgerow, moor and mountain and sky, as it slowly unfolds before them.

These last are the people for whom this book is intended first and foremost. Its object is to give to the ordinary man or woman interested in nature the general background of the knowledge acquired by specialists and students. We cannot all become experts in botany, zoology, entomology, geology, or meteorology; indeed the knowledge needed for a proper understanding of any one of these subjects is too vast for even a trained scientist to become master of them all. But if we are interested in nature at all, we can use that interest as the foundation upon which to build a clearer apprehension of the marvels which attend even the shortest expedition from the town into the countryside; and this book will help to clear the ground for that foundation.

Nature has been the inspiration of writers and artists since man first became capable of any permanent expression of his thoughts. Innumerable books, from the clay tablets and papyrus of the ancients to the printed page of modern times, have extolled and explained her many aspects. Contemporary works on this apparently inexhaustible theme are numbered in their hundreds, and each year brings many new contributions. The books about the nature life of the British Isles alone would form a respectable library. Why, then, it may be asked, add yet another book to this vast literature?

Several good reasons can be offered for doing so. The most cogent is that there does not exist any other book which covers in detail, and in a practical yet popular manner, the whole field of nature study within the limits of the British Isles. The comprehensiveness of our OUTLINE OF NATURE, gathering together as it does in these three volumes a complete guide to practical nature study "on our own doorstep," is its main justification.

TO gain in any other way the insight into nature which these three volumes can justly claim to reveal to him, the nature-lover would have to accumulate for his home library several volumes about ferns and fungi; at least half-a-dozen books on butterflies and moths; as many more on British birds and their eggs; others on trees; while to include in his studies the wild animals and reptiles of Britain, the freshwater fishes and marine creatures, the insects, and the common subjects of field geology—to say nothing of that tantalising subject, the British climate!—would entail a further selection of separate works. Even when he had accumulated his library, the nature-study amateur would find that many of his books were written by experts only for experts, possibly in terms incomprehensible to him.

And where else than in these three volumes would he find such a collection of photographs illustrating nature and wild life in all their moods?

IN our method of presenting the vast number of subjects covered in this work, we have set ourselves something quite new. Instead of treating each section of nature study as a continuous whole, the great range of interests is reflected by the splitting of each subject into chapters and the alternation of diverse chapters throughout the three volumes. Each chapter is in itself complete and sufficiently long to avoid any suggestion of scrappiness, but none is allowed to run to such length as to tire the reader whose interest is general rather than specialised. A glance at the pages of contents at the beginning of each volume will make the scheme clear and will help such readers as may wish to pursue one section at a time. On the other hand, our method makes the volumes ideal for browsing over—say, in that tired, happy mood which may settle upon us after a long country walk. Either way of using the book is bound to be profitable.

Attached to many chapters will be found practical notes which will provide a great amount of information of immediate use to all those readers—and it is hoped they will prove to be the majority—who are not content with mere book-study of nature but seek to increase their

knowledge of her ways by personal investigation and experiment. The notes on such matters as flower pressing, butterfly collecting, etc., should prove of great value to school-teachers as a help in awakening among their pupils an enthusiasm for field study.

Every chapter in the OUTLINE OF NATURE has been specially written for the work by an authority in each individual field of study; an expert who not only possesses the recognised qualifications but has the ability to make his subject clear to the inexpert. It is not claimed that any one section in these volumes exhaustively covers the whole field of the subject with which it deals, for within the limits of 1,568 pages that would be an impossible task. But everything essential is here.

At the same time, page after page of the most lucidly written letterpress may still fail to give the reader a real picture of the author's subject. For that reason the OUTLINE OF NATURE has made use of photographs on an unusually lavish scale. The illustrations are reproduced in the clearest possible detail, so that both the student and the general reader have an immediate eye-guide to the identification of any bird, animal, insect, flower, or plant. These photographs, many of them published for the first time in this work, have been carefully chosen from the collections of the leading nature photographers of our day. The photogravure pages contain a wealth of pictorial matter of high educational value, and represent animal and flower photography at its best.

By confining the scope of the OUTLINE OF NATURE in word and picture to the botanical, zoological, and geological phenomena of the British Isles alone, we have aimed at avoiding that vagueness and remoteness which tend to characterise works of natural history dealing with the flora and fauna of the whole world. Moreover, whatever is described in these pages can be seen in actuality by any rambler in the British countryside or visitor to the British seashores.

NOT only is the OUTLINE OF NATURE meant to be consistently perused for entertainment and enlightenment, but it can also be quickly consulted at any time as a work of reference. The final volume includes a comprehensive index guiding the reader to any word upon, or picture of, any detail of natural history and wild life in the British Isles.

To sum up: whatever your status so far as nature is concerned, you will find in these pages a wealth of information, easily comprehended, and illustrated by hundreds of delightful pictures. For the often-puzzled but ever-curious townsman as he steps away from his familiar pavements to seek peace in wood and field, on cliff or moor, it is a storehouse of facts and of answers to a thousand wondering questions. And we would be prepared to wager that the countryman, too, however close to nature he may live, will find herein much that is new and enthralling.

Dixon-Scott

Spring Comes to the Countryside

For months past the hand of winter has lain heavy on the land. The trees have stood naked in the wind, shivering listlessly at its icy touch, while on the ground at their feet the leaves of yesteryear, brown and withered, have been whipped hither and thither by every passing gust or squelched into the mire by the tread of man and beast. The birds, or such of them as have resisted the call of warmer climes, have flitted in ones and twos from bough to bough or explored anew for the thousandth time the skimpy hedgerows and barren fields. The surface of the pond has reflected the hue of a leaden, cloud-filled sky, and the river has swept on in a steady, voluminous rush, bearing in its muddied stream lonely leaves and broken boughs.

There has been rain—days and weeks of it; frost has sealed the ground with a covering of rime; there have been thaws, days when we thought that spring was at last knocking at the door, when the swollen rills bubbled and gurgled, when the birds sang a livelier tune, and a flower or two, some shoots of green, began to appear amid the tangled dead by wayside and ditch. Then the frost has come again, as full of menace as ever, and its grim passage has scared away the trembling harbingers of spring, has direly punished the overbold for their unseasonable venturesomeness.

Day after day has come and gone, and as each calendar-leaf has dropped into the paper-basket we have had the unspoken thought that though winter is with us yet, spring's coming is one day nearer. Looking through the rain-tapped panes on the sodden garden, at the hills half-hidden by tempestuous clouds, at the gaunt trees swaying in obedience to the gale's behest, we have felt it difficult to convince ourselves that all this—the cold and damp, the greyness and the storm—will pass, and that even now, down in the damp darkness of the earth, the processes of Nature's marvellous alchemy are at work, this year as in all the million other years that have elapsed since a tilted world first produced the cycle of the seasons.

Lengthening days have enlarged our hope, fortified our certainty—and at last all that we have longed for has come upon us in the vernal rush. First, the frosts retreated, withdrawn in gradual measure as if in obedience to some directing general; then the gales died down, the storm clouds rolled away and the azure of the sky, that had been revealed so seldom in the past few months,

spread widely and endured. The very air became softer and more kind, a genial warmth stirred the long-sleeping denizens of the soil into life.

In Britain we experience nothing like the sudden spring of the northern lands. With us winter is long a-dying and its successor's travail is often wearingly slow; but then with us spring—the most delightful season of the year—is not a matter of a few days, packed with vital incident, but a long colourful procession of delights, as bird and beast, tree and flower, speeding fish and hurtling insect awake to the new or renewed life that is theirs.

The whole constitutes a poem of colour, sound and movement—a poem which all the poets of our race have striven their hardest to perpetuate in music-full word and jocund phrase. Medieval and modern, Jacobean, Georgian and Victorian—all have sought and found the springtime inspiration, but of all men the Elizabethans were surely most in tune with spring. Here, for example, blithely carolling, comes Thomas Nashe:

> Spring, the sweet spring, is the year's pleasant king.
> Then blooms each thing, then maids dance in a ring.
> Cold doth not sting, the pretty birds do sing—
> Cuckoo, jug-jug, pu-we, to-witta-woo!
>
> The palm and may make country houses gay,
> Lambs frisk and play, the shepherds pipe all day,
> And we hear aye birds tune this merry lay—
> Cuckoo, jug-jug, pu-we, to-witta-woo!
>
> The fields breathe sweet, the daisies kiss our feet,
> Young lovers meet, old wives a-sunning sit,
> In every street these tunes our ears do greet—
> Cuckoo, jug-jug, pu-we, to-witta-woo!
> Spring, the sweet spring!

The farmer has small time for these poetic joys. Even during January, the most inactive month of the year in his calendar, there is work to be done. Weeds grow apace unless checked, ravenous crows work havoc with sprouting corn unless held at bay by gun and rattle, machinery must be overhauled and kept in good order, and the farm as a whole must be subjected to a long and thorough process of spring-cleaning though spring be yet weeks away.

Then in February the hedges must be cut and trimmed and the ditches cleared of their choking growth, and it may be that now the first lambs make their appearance in an inclement world. With March's arrival life on the farm becomes much more vigorous and varied. The young cornshoots are rolled; ploughs throw up the soil in even furrows; harrows cross and re-cross the far-spreading acres; and then by speedy machine or expert hands the crops are sown or planted.

For the townsman, too, the coming of spring means the call to increased activity, though in his case the call is one to increased pleasure instead of intensified labour. During the winter months the urban members of our community tend to forget rural delights, preferring the lights of shops and cinemas to the dripping murk of country lanes; but as soon as spring comes, "hiking" boots are fetched out of store, shorts and coloured shirts are mended, camping and tramping equipment refurbished or replaced. Then, if the weather be kind, crowds of ramblers and campers, by train and omnibus and coach, make for the countryside to recapture the healthful joys of the open air.

AFOOT IN SPRINGTIME

For town-dwellers the coming of spring is a reminder of rural scenes and ways that have been forgotten during the months of darkness. At Easter thousands of young and young-minded folk get out their "hiking" kit and set off on the first country tramp of the year. This photograph is of a party of ramblers at Coldbarbour, Surrey.

UNTAMED SHARERS OF MAN'S WORLD

CENTURIES ago the wild life of Britain was much more plentiful and varied than it is today, but though such creatures as the wild boar, the aurochs, and the wolf have been long extinct, the creatures of the friendly—and not so friendly—wild are still much more numerous than is generally supposed. Rabbits and hares, foxes and squirrels, hedgehogs and moles—these everyone knows, but there are dozens of other wild creatures living their lives almost unnoticed in these islands of ours. None of them will escape notice in our pages

Of late years the study of Natural History has been largely abandoned in favour of the investigation of animal life in the laboratory. "Natural History" has even undergone a change of name, and its subject matter is now generally known among scientists as "Animal Ecology."

The discoveries of Charles Darwin in the middle of the nineteenth century gave such a tremendous impetus to the study of species and the classification of animals that within a few years of his epoch-making work the entire zoological world was forced into museums and laboratories, to spend the next half century or so in working out that classification and description which have paved the way to the study of zoology today. It is only within the last few years that scientists in general have begun to show a revived enthusiasm for this "new" science of Animal Ecology, or have taken an interest in the study of animals in their natural surroundings.

Berridge

DESCENDANT OF THE MIGHTY AUROCHS

In bygone days the wild ox roamed the British thickets in considerable numbers, but almost its only modern representatives are the much smaller and only half-wild cattle at Chillingham Castle, Lord Tankerville's seat in Northumberland. A member of this famous herd—now maintained by the Chillingham Wild Cattle Association—is seen in this photograph; this herd, with the Cadzow and Chartley herds, are pictured in pp. 577-79.

The very words "Natural History Society" have about them a tang of the Victorian era. These "societies" in which our grandfathers, and in some cases even our grandmothers, combined to increase the pleasure derived from their country walks, differed very little from the rambling and "hiking" clubs of today. There was, however, a period of two or three decades when the out-of-doors lapsed from favour, but the "Youth Movement" has reopened the possibilities for this kind of research in zoology, and we can only hope that the work yet to be accomplished by the new generation will have the same immense value as that of the last century. Animal Ecology, Natural History, Zoology—call it what you will—is, practically and economically speaking, a valuable science and, in addition, undoubtedly one of the most fascinating of pastimes.

Ecology—the word is derived from the Greek for house—is the science which deals with all forms of life in relation to their habitat or natural surroundings. Animal ecology is a study of the distribution of the various species of animals, and endeavours to explain why they choose for their homes the particular parts of the countryside in which we find them. These regions, or habitats, are so overwhelming in their numbers and so hopelessly confused and interdependent upon one another that it will be many years before their classification can be completed. Biological surveys have been undertaken in most countries in the world—*except* England and China; but it has been stated on expert authority that there is more true animal ecology in the Old Testament and the plays of Shakespeare than in most of the zoology textbooks ever published. It will be readily realized, then, that there is a very great deal of work yet to be done which is well within the capacity of the average Nature-lover.

The first aim of the naturalist should be to observe; and the second, which is of equal importance, is the keeping of a record. Observation is an art. Hundreds of people will walk past a day-singing nightingale in a roadside hedge without being able to distinguish the sweet, strong notes from those of a thrush; yet they will wait patiently through the interruption of a summer evening wireless programme in order to hear just a few bars of the nightingale's immortal song. We cannot appreciate lovely sounds or even any beautiful sight unless we are artificially keyed up to do so, unless we have learnt *how* to listen, *how* to see. A love of Nature is inborn in most people, but through preoccupation and the tempo of modern life it is often allowed to lie dormant and its very existence may remain unsuspected. It has been said that "brains and a lead pencil" are the only indispensable equipment of the naturalist; but even these two essential attributes are useless without a wholesome curiosity and a real appreciation of the masterpieces of Nature.

Animal habitats are chiefly dependent upon the distribution of food. We should not expect to find a

nest of baby rabbits under the floor-boards of our house, though we should not be surprised to disturb a community of mice. The habitats of mice and rabbits differ as much from one another as do the two foods, cheese and grass. The ecology of plants plays an important part in the distribution of animals. Without plants the very existence of animal life, including that of Man, would be impossible.

As is explained in the opening chapter in the section devoted to the Landscape of our Land (page 30), the Earth is composed of rocks made up of minerals containing inorganic, or lifeless, chemical salts. The breaking down of the rocks, through weathering, gives rise to the production of soils, which naturally enough contain all the salts previously included in the composition of the rocks. Through the action of sunlight and the absorption of these salts in solution the plants are able to vitalize them, to make them " live " as it were, and to turn them into organic or living substances which can be eaten and digested by animals.

To be successful in our search for wild animals in their natural surroundings it is advisable that we should know something not only of their habits, but of the food they eat. Some animals, of course, depend entirely upon other animals for their food, i.e. the carnivorous (Lat. flesh-eating) and insectivorous (Lat. insect-eating), but the flesh or insect food is only sustaining because it is obtained from animals which have themselves devoured the plants which make life possible. Without exaggeration, then, we may say that, whether directly or indirectly, all life is based on vegetarianism.

Classification of the Animal Kingdom

MAMMALS are those animals which suckle their young after birth, and they are divided into six orders or main groups, viz.: Insectivora, e.g. shrews, moles, hedgehogs; Cheiroptera (Gk. *cheir*, hand, *pteron*, wing), e.g. bats; Carnivora, beasts of prey; Rodentia (Lat. *rodere*, to gnaw), gnawing animals; Cetacea (Lat. *cetus*, large fish or whale), swimming animals, almost fishlike in appearance, such as the whales and dolphins; and the Ungulata (Lat. *ungula*, hoof), of which the horse and donkey are well-known members.

The Reptiles (Lat. *repere*, to crawl or creep) are animals which do not suckle their young but lay eggs. Unlike the mammals, they are cold-blooded, and if they have legs at all, these are of an extremely simple and rudimentary nature. The majority of the reptiles found in Britain are insectivorous.

Many of the wild animals to be described in detail in later pages have a very limited range in the Britain of today. Deer, for example, are found in a truly wild state only in the Scottish Highlands and on the West Country moors. Even so, however, they may be studied as tolerably free animals in the New Forest, Epping Forest, and in many of our great parks, such as Windsor and Richmond, as well as in private reserves. To the deer we must add the wild cat and the Alpine hare as mammals that have to be looked for in special restricted areas, but all the other wild animals dealt with in this series can be met with, sooner rather than later, in the shortest of country walks.

Moving Days in the Animals' Calendar

THE animal personnel of every habitat is constantly changing with the ebb and flow of the seasons, variations in the weather, and a number of other periodic rhythms of the countryside, and in consequence it is never possible to observe all the members of an animal community at the same time. It is not the slightest use looking for the dormouse in the January woods, and a search for the hedgehog would prove equally fruitless. Those animals which do not sleep or hibernate through the long winter months are best sought for at that season, for in the summer, when nearly every living thing is awake, they will be overwhelmed by the numbers of the non-hibernating and perhaps pass unseen.

It must be understood, therefore, that animal communities vary in personnel not only from place to place, but from time to time. There are summer and winter "terms" for the various species, and day and night " shifts " in all seasons. There are wet and dry weather " sets " of animals, and there are also those which stay in a given location only for a very short period of the year. The woods, the downlands, the moors, and the cultivated hedgerows—these are all obvious habitats of varying species; while summer and winter, day and night, are the most clearly defined of the time-community divisions.

It is often hard to realize here in Britain that Man is surrounded by a vast and intricate maze of animal communities. The influence of Man himself upon these communities goes also, for the most part, unobserved. Principally through Man's influence and the spread of civilization, many beautiful and extremely interesting animals have disappeared from the countryside of Britain, and in some cases from the world altogether. There are now no beavers in our rivers, no wild boars in our woods; and the aurochs, the short-horned wild ox, the brown bear, and the wolf have been driven for ever from their native haunts within our shores.

Man has, however, been settled in Britain for such a long time that he has struck a fairly even balance with the animals around him, which have learnt so thoroughly how to live and let live—far more thoroughly than Man, let it be said—that we are apt to let them go unobserved. In Africa, South America, or Australia, where Man in a highly civilized state is new to the country, the animal life about him is still readjusting itself to his presence, and we hear the typically colonial tales of lions, snakes, locusts and even rabbits

WILD ANIMALS OF BRITAIN

In the opposite page are illustrated some of the more important members of Britain's wild fauna at the present time. 1, Adder; 2, Hedgehogs; 3, Squirrel; 4, Wild Ponies; 5, Hare; 6, Grass Snake; 7, Otter; 8, Rabbit; 9, Red Deer; 10, Wild Cat; 11, Badger; 12, Lizard; 13, Fox; 14, Mole; 15, Weasel; 16, Shrew. All these and many more will be fully described and pictured in later chapters included in the section "Our Wild Animals and Reptiles," but their photographs are placed here in juxtaposition in order that some idea may be conveyed of the variety of wild life that still persists—and in some cases, at least, multiplies—in ditch and bank, in field and on moor, in woodland and open country, and on mountain slopes. Many a wild denizen of the countryside has proved too wild for Man to endure as a close neighbour, but still there are dozens of different creatures which, by a process of "live and let live," flourish, albeit in most cases surreptitiously, in the near vicinity of the haunts of men.

G Bird

SEEING BUT UNSEEN

Animal observing is a "sport" of recent development, but its superiority over the killing activities of the older school of sportsmen is becoming increasingly recognized. As wild animals have learnt by long experience to be shy of men, would-be watchers of their ways have to build specially-designed "hides," such as those shown here, from which they may watch without their presence being noticed by the objects of their study.

disturbing and interfering with his colonizing activities. Because, however, our little animal population of Britain remains apparently undisturbed, without open revolution or warfare, it does not mean that it is any the less interesting and that these revolutions and wars are not taking place. The struggle for existence goes on whatever the conditions imposed. The animal life of our woods and moors is of no greater interest to the true naturalist that that of our farmlands and hedgerows, or even our parks, where the works of Man come into close contact with the results of Nature's fashioning.

The red deer, the wild cat, the badger, and the otter are to be found wild and free on our moors and by our streams. Squirrels, both red and grey, leap from branch to branch among the trees of our woods and parks. There are multitudinous rabbits to be seen on our downs, and hares race through the standing corn and make their "nests" in the long grasses of our fields. In the heat of summer snakes can be seen slithering among the heather, and tiny lizards basking in the warm sun. There are stoats and weasels hunting in the woods for prey, while the spiny hedgehog is sleeping away the days and nights of the winter months.

The frost-bound fields of winter have their charm but with the dawn of spring the world awakens and the endless search for food goes on as it has for countless centuries. Hundreds of different species are helping and preying upon one another. At night the bats come out and the viper wriggles through the grass.

He who leaves his fireside and steps out into the fields and woods will find himself in a strange world where natural beauty and the drama of Nature go hand in hand

Hosking

HOW TO 'STALK' WILD ANIMALS

The observation and tracking of wild animals is an art only to be acquired as the result of long experience and patient trial. The first thing to remember is that the majority of the non-human inhabitants of the countryside go more by their sense of smell than anything else, and the amateur naturalist should take care, therefore, always to approach his objective "up wind," i.e. in such a way that the wind travelling towards the animal is free from human scent and is blowing towards the observer and not vice versa.

The larger animals, in particular, such as deer and the wild ponies of the New Forest and Dartmoor, rely almost entirely upon their olfactory (smelling) organs to warn them of approaching danger, and it is well to know that even the wildest game may be approached within a few yards if a strong gale be blowing and due care be taken. It is advisable, too, to keep in mind that wind can carry sound over great distances, and that it is hard to hear the advance of the clumsiest of enemies coming "up wind" when there is even a moderate breeze blowing.

Approaching the Quarry

Colour, movement, smell and sound are the four things which may "give away" the amateur naturalist when he is striving to get a view of wild life in its natural surroundings, but all may be overcome by paying due regard to wind direction clothing and the speed of approach.

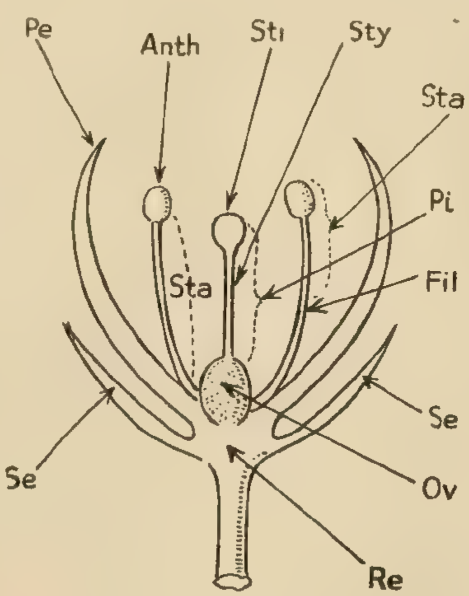
Animals should always be looked for in their distinctive habitats; it is clearly absurd to expect to find wild deer in the open fields, where perhaps only a few mice and possibly a fox may be discovered. It is a good plan to carry a camera, but an hour or two hours of careful observation are really of greater value than a dozen of the best nature photographs ever snapped. Then always make notes of everything you see—not on the spot, for white paper shows up and frightens animals, but after you have finished your observations. The ability to observe and make reliable mental notes at the same time is well worth cultivating.

FLOWERS IN GENERAL: AND THE PRIMROSE

In springtime and summer every step in a country ramble brings us into contact with some fresh floral marvel. Our wild flowers of wayside and woodland are legion, and only a library could profess to deal in comprehensive fashion with the British flora. Here, however, we are on the threshold of the kingdom of the flowers, and all the blossoms that are likely to attract and hold our wandering eyes are dealt with in the series of chapters of which this, on the primrose, is the first

THE desire to know by name, and to be able to recognize, the common objects of the countryside is one which almost everyone experiences at one time or another. The flowers, in particular, of wayside, woodland and meadow awake the rambler's curiosity, but in all too few cases is the curiosity succeeded by a real increase in knowledge. We wonder, question—pass on and forget. Upwards of 1,200 flowering plants and trees may be found in a wild state in the British Isles, but the number of persons who can recognize and name even a hundred is pathetically small.

No doubt this is due in part to lack of opportunity, but the fact that flowers are inevitably connected with Botany, remembered as one of the least interesting subjects of one's early schooldays, is another contributory factor. A further reason may be found in the absence of simple guides which explain not only the appearance of the flower and its manner of growth, but also its relation to other flowers, to scenery, and especially to the better-known garden flowers.



PARTS OF A FLOWER

This diagram shows the principal parts of a flower. Anth., anther; Fil., filament; Ov., ovary; Pe., petals (corolla); Pi., pistil; Re., receptacle; Se., sepals (calyx); Sta., stamen; Sti., stigma; Sty., style.

The normal flowering plant consists of a number of more or less definite parts—any one or more of which may, however, be absent. The chief parts are the following: root system, which may be one of a number of types; stem, which may be simple or branched; leaves, which are borne on stalks from the stem, or in some cases directly on the stem; and inflorescence, or flower system. The last of these, after the period of flowering, bears the seeds which arise from the fertilized flowers.

Plants may be either annual, in which case their life is only for one year, or perennial, in which case they may live for a number of years. Some perennial plants die completely away during the winter, others remain above ground but do not grow during the winter. In the latter case the shoots for the new year may rise direct from the old root or they may come from the stem of the previous year. It is obvious that if they come, year after year, from the same old stem, which is growing the whole time, a bush or tree will gradually be formed.

The root may be long, fine and trailing; it may form some sort of a storage organ, such as a bulb; it may be short and thick, when it is called a rootstock. Roots are generally of little value in plant identification.

Besides being either simple or branched the stem may be stiff and woody, persisting (though dead) throughout the winter, or, again, it may be trailing or creeping along the ground or over other plants. Both stems and roots may be parasitic on either the roots or stems of other plants.

LEAVES are of many types, the more simple being those illustrated in page 10. Leaves that are borne direct on the stem are termed *sessile* (Lat. *sessilis*, sitting). A *simple* or *entire* leaf is one that is plain, with uninterrupted border, and smooth contour. The leaves, besides being sessile, may clasp the stem in a lesser or greater degree. Where a single leaf surrounds the stem or where two leaves, growing opposite each other, join so that the stem appears to run through the middle, the term *perfoliate* is used. A long narrow leaf, such as a blade of grass, is called *linear*; if it is equally pointed, but stalked and much broader at the lower end, it is *lanceolate*, or lance-shaped.

A very common type is the *ovate* (Lat. *ovum*, egg), a pointed leaf broadest at the base, less than twice as long as it is broad; where the base is narrow, the leaf is *obovate*. Similarly, a *cordate* leaf is one that is heart-shaped (Lat. *cor*, heart), while *obcordate* is a reversed heart shape, in which the point runs into the stalk of the leaf. A leaf that has two ear-like projections at the base is *hastate* (Lat. *hasta*, spear), or halbert-shaped; an alternate form of this is one in which the ears project back behind the stalk, to give an obvious arrow shape. In some instances the stalk gradually flattens out in forming the leaf, which is then termed *spathulate* (Lat. *spatula*, diminutive of *spatha*, spoon). A leaf-like growth that shields the inflorescence is often simply termed a *spathe*.

NUMEROUS plants have what are termed *compound* leaves, that is, each leaf consists of a number of leaflets, which may be arranged according to several different systems. The commonest types of compound leaf are the *palmate*, in which the leaf is cut up deeply into a number

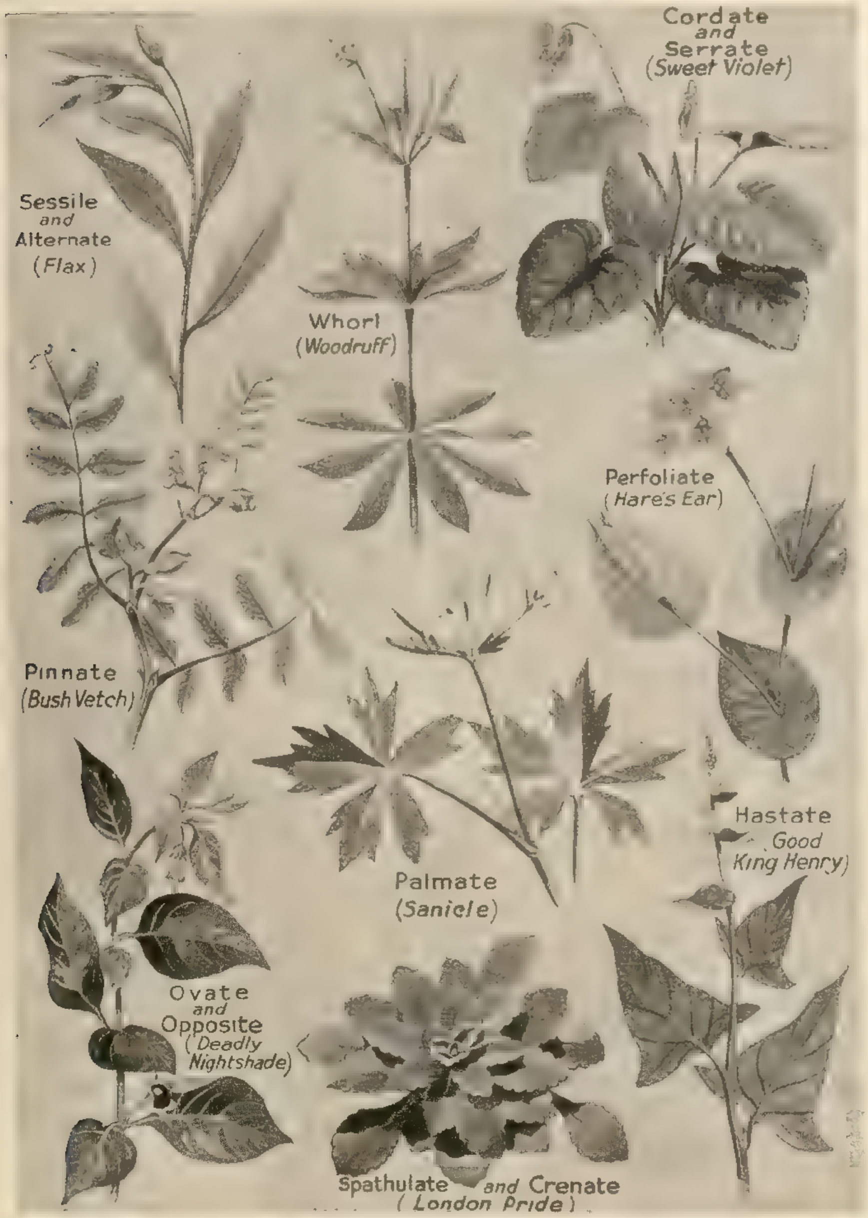
of segments or lobes, all more or less long and narrow; and the *pinnate* (Lat. *pinna*, feather), in which one midrib bears leaflets up either side, with usually a single "terminal" leaflet at the top. These leaflets may themselves be cut up more than once to make an even more compound leaf. Other types of leaf are those in which a number of small sessile leaves are found all round the stem at the same point, in which case they are said to be whorled, or to form a *whorl*; when such a whorl occurs at the level of the ground there is said to be a *rosette*, and when the leaves spring direct from the root system they are said to be *radical* leaves (Lat. *radix*, root).

Besides the above general forms of leaves, the actual edges may vary. A *serrate* (Lat. *serra*, saw) leaf is one in which the edge has regular and pointed teeth; the term *crenate* (Lat. *crena*, notch) is used of a leaf whose edge is cut into little concave lobes, and *dentate* (Lat. *dens*, tooth) of one having on the margin small cuts of a concave nature. Leaves are termed *alternate* or *opposite*, according as to whether they appear at a distance from each other, or at the same spot, on opposite sides of the stem.

FINALLY, the surface, upper or lower, of the leaf may give us valuable clues as to the identity of the parent plant. It may be smooth, or hairy, or spiny, or mealy, that is, covered with a white flour-like powder on the underside; many leaves are downy also, and a few are covered below with quite a thick mat of woolly hairs. The leaves of certain plants bear glandular hairs, and others are covered with a slimy, sticky substance. The texture, also, of leaves helps in identification; it may be fleshy, or leathery, or hard and brittle. In many plants, such as the wild roses, there are at the base of the leaf stalk two small outgrowths of a leafy nature; these are called *stipules*, and similar growths at the base of flowers are known as *bracts*.

Flowers vary enormously in size, shape and colour, as well as in their internal structure, but in general the forms that chiefly concern the average Nature-lover may be simply identified by means of the combination of the above features with the habitat, time of year at which they are flowering, and type of seed vessel that supersedes the dead flowers, and by carefully noting the other flowers growing with them.

IN describing flowers, reference must be made to the constituent parts of the flower. The diagram in the preceding page shows the important features of the normal flower, and some slight explanation of their various functions may be of value. The *petals*, which are the part that is normally brightly coloured and hence attracts the eye, are termed as a whole the *corolla*, while the *sepals*, which in the bud form a protective sheath for the rest of the flower, combine to form the *calyx*. The sepals are in many flowers coloured, and if they are indistinguishable from the petals the two series are collectively termed a *perianth*; sometimes the sepals persist long after the petals have fallen, and they may take very brilliant colours in the autumn. All the sepals or petals may be joined together in such a way as to form a tube, and one or other or even both may be entirely absent. The fleshy base to which these and all the other parts of the flower are attached is called the *receptacle*, and it comes at the head of the flower stalk. Besides the corolla and calyx, the receptacle bears



LEAVES OF VARYING SHAPE AND SIZE

Plant leaves partake of an infinite variety, but they may be conveniently classified into a number of groups according to the method by which they are attached to the plant stem, their shape and structure. In this diagram some of the principal types are represented by plants characteristic of the flora of the British Isles.

two sets of organs, the *stamens* and the *pistil*, representing the male and female parts of the flower respectively. One or other of these sets may also be absent. A stamen consists of a small oblong body, the *anther*, carried at the top of a stalk known as the *filament*; the anther, which is usually divided in two by a groove down the centre, contains the *pollen*, the male element in fertilization. The pistil, which is borne centrally, with the stamens round it in a ring, is composed of *ovary*, *style* and *stigma*. The ovary contains the *ovules*, each of which when fertilized may give rise to a new plant; the style is in reality a tube supporting the stigma. Down it the male element, which has entered by the stigma, must go to fertilize the ovules. Pollen may reach the stigma in a number of ways, e.g. it may be wind-borne, or it may be brought by bees or flies or other insects. It should be added that the number of these organs varies enormously in the different plants.

Main Divisions of Flowering Plants

FLOWERING plants are divided broadly into two great groups, the Dicotyledons and Monocotyledons (Greek, *di-*, two; *mono-*, one; *kotyle*, cup), according as to whether there are two embryonic leaves or one when the seedling first appears. Below this primary grouping there are numerous subdivisions based on the structure of the flower, but as far as concerns the field naturalist the most convenient division is that into "orders," since it is one which groups together plants whose common characters are usually obvious to the naked eye. References to this classification will be frequent in these chapters, and, wherever possible, the various members of an order will be compared to enable their common characters to be easily grasped.

A flower which shows to advantage all the regular features already mentioned, and at the same time one which is among the best-known of our native flowers, is the common primrose. The typical member of its own order, the *Primulaceae*, it is one of the most characteristic of our spring flowers, being common throughout the British Isles. There can be scarcely anyone, however little used to the country, who has not at one time or another seen the quiet, unassuming bunches of pale, creamy-yellow flowers in the leafy hedgerows or carpeting the ground beneath the hazel scrub in an oak wood.

Where the Primrose is Seen at Its Best

To see the primrose at its best one must find a light, damp wood, and preferably an oak wood, for it is a very typical example of the well-marked flora that is associated with oak woods. Given a fair amount of moisture, the primrose will send up flower stalks as much as nine inches long, with equally long tufts of leaves. The leaves grow in a rosette, and each flower is borne on a separate stalk, although there is, hidden deep among the leaves, a stout common stem; the number of flowers produced by a single plant varies, but as many as twenty may be found in a favourable situation. A variety of the primrose is sometimes found in which the normally hidden stem is prolonged upwards.

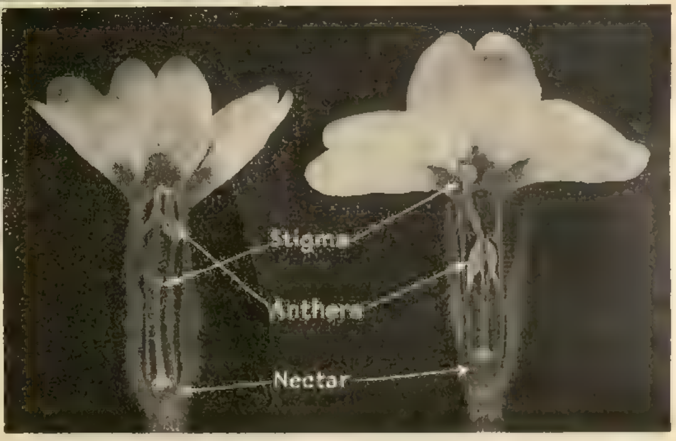
In a wood where primroses are at their finest, say about the middle of April, their scent is so sweet that the air may be quite heavy with it. Although the practice is one to be strongly deprecated, at any rate on a large scale, the primrose is a flower which is especially easy to transplant, and, given fair conditions and a not too exposed situation, it will flourish wonderfully well in the garden. If it is dug up, the root will be found to be a hard, thickish, pink rootstock, the leaves springing from the top without any real stalk. The leaves themselves are wrinkled, and of a shape botanically described as obovate, that is, broadest at a point near the tip—

Dixon-Scott

IN THE SITE THEY LOVE

One of the delights of a country ramble in springtime is the wealth of lovely wild flowers that may be had for the gathering. Unfortunately all too many visitors to our lanes and woods are not content with culling a blossom here and there, but grub up the plant by the roots, thus contributing in considerable measure to the destruction of what they profess to love.

order reversed, the style being so long that the stigma may be seen occupying the mouth of the corolla tube, while the stamens are attached to the wall about half-way down inside. These two forms are recognized by country children as "thrum-eyed" and "pin-eyed" respectively, and, indeed, in the "pin-eyed" the stigma looks remarkably like the head of a pin in the



Bustin

'PIN-EYED' AND 'THRUM-EYED'

In some primroses—the "pin-eyed"—the stigma is at the mouth of the corolla tube with the anthers half-way down; in others—"thrum-eyed"—the positions of stigma and anthers are reversed. A bee in its search for nectar picks up pollen from the anthers of a flower of the one type, and deposits it on the stigma of a flower of the other type. Both types are illustrated in the photo on the right; above is a photograph of a cluster of the "pin-eyed" variety

which is, however, slightly pointed—and narrowing away gradually towards the lower end. The midrib is broad, and in the larger leaves is very noticeable.

In the bud the calyx is almost as long as the corolla, but when the latter has opened it grows upwards. On examination of a flower, it will be seen that the corolla is fused to form a tube, which opens out at the top into five lobes representing the petals. At the base of each of these, near the mouth of the tube, there is a very conspicuous patch of a deep orange colour. Varieties are occasionally found in which there are only four lobes.

The primrose is an interesting example of what is known as a dimorphic flower, that is, one that has two distinct forms. In one form the stamens appear at the top of the tube, to which they are attached, and in this event the stigma will be found half-way down the tube, the style being rather short. The other form has the mouth of the corolla tube. The reason for the existence of these two varieties was first pointed out by Charles Darwin, who discovered that it was a very simple and automatic method of ensuring cross-fertilization. By using a piece of fine grass as a substitute for the tongue of a bee this can easily be confirmed. Pollen picked up from the deep stamens of a long-styled flower will inevitably be transferred to the sticky stigma of a flower whose style is short, since style and stamens grow at the same level in either case. Similarly, when the bee visits a short-styled flower, it picks up pollen from the mouth of the corolla tube, and this is transferred to the stigma in the mouth of a flower with a long style.

Of the other species of the primrose genus found in the British Isles, two, the cowslip and the oxlip, are described in a later chapter. Then there are the bird's-eye primrose and the Scottish primrose, with lilac-pink and bluish-purple flowers respectively.

WILD FLOWERS: Practical Hints

The identification of the flowers encountered in his rambles is one of the first objects of the student of Nature, but to the beginner, at least, this often presents considerable difficulty. Much can be gathered from a careful study of the features of the plant and the flower itself, as well as of the environment in which it grows, but sooner or later the student will be forced to have recourse to some scientific classification. Such an arrangement has been in universal use for many years, in the case of the plants as with all other natural objects.

The flowering plants form only one of the several divisions of the vegetable kingdom, namely the *Phanerogama* (Gr. *phaneros*, visible; *gamos*, marriage), which is again divided into classes, sub-classes, divisions, sub-divisions, and then natural orders. Below these there are genera (plural of Lat. *genus*, kind), that is, plants all fairly closely related as regards a number of major points, and species (Lat. *species*, kind or sort), the final division into individual types. Many botanists make further sub-species, often on what appear to be very slight grounds, when, for instance, the plant is altered in accordance with its environment. In so far as the amateur naturalist is concerned these minor points may be ignored, although occasionally a variety may be found that is of obvious interest.

Keep a Note-book

It is for this reason that the keeping of notes is as necessary when dealing with flowers as with any other objects of Nature study. The beginner should make a point, for instance, of noting the first dates in every year on which he observes each particular plant to be in flower. There are always exceptions to the general rules, and many single flowers may be found even in January. It is best in these cases to make a special note and wait until the main flowering period is observed.

Importance of Location

Along with the date of first flowering, some notes of the locality are an obvious necessity—if possible, remarks as to the exact situation of the plant. Some plants may be found to bloom early in a sheltered spot, others may prefer an open position; weather may exercise a decided influence, and so, too, may the appearance of insects on which the flower is dependent for some part of its life-history. If any plant is definitely identified as a certain species, and yet appears to be very abnormal, a special note should be made; reference to a book which gives the rarer varieties may show that it is a sub-species not previously found in that particular district.

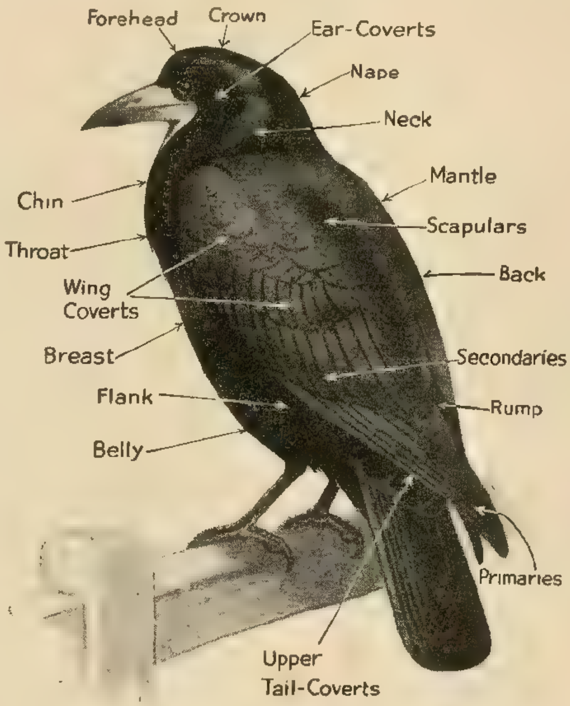
BRITISH BIRDS IN GENERAL: AND THE ROOK

MANY are the birds that sing in the British hedgerows, that skim its pools and rivers, that have their homes in its tree-tops and in dizzy nooks on its craggy cliffs. Their life-histories are packed with strange happenings, and even the most expert and experienced ornithologist finds it necessary to be ever on the alert for fresh marvels. Each of the principal species known to Britain will be fully described under the heading of Our Birds and Their Eggs, and below, after some introductory observations, we learn of the rook

MORE than any other nation, perhaps, the English deserve to be called a nation of bird-lovers, but nevertheless it is remarkable how few of our birds, even the most common species, are known to the majority of people, either by sight or by sound. This applies as much to country people as to town-dwellers; indeed, it is from the latter class that many of the finest and keenest bird-watchers come. In this series of chapters on Our Birds and Their Eggs, a full description of most of our common birds will be given; their appearance, habits, nests, and eggs will all be dealt with, and at the same time there will be included a host of those small, apparently insignificant facts that go to give each individual species its peculiar character.

Of recent years much has been done in the way of bird protection. Acts of Parliament have been passed, laws have been more rigidly enforced, and bodies concerned with the subject have vastly increased their activity, but it is only by the cooperation of every Nature-lover that any real protection can be ensured for the future. Several of the former enemies of birds are, it is good to know, gradually passing; the collector, both of eggs and of skins, is a comparatively rare figure nowadays, and the type of man who shoots a strange bird merely to see what it is and looks like at close quarters is even rarer. The undiscriminating farmer is still the birds' greatest enemy, but a new generation of men who can tell friend from foe is gradually taking over the land. The larger birds, in particular, have suffered severely in the past from the gamekeeper's gun, but here, again, new knowledge has shown that many an alleged harmful bird is an unrecognized friend.

As regards egg-collecting, there was a time when every boy inevitably included this among his hobbies, but it is now perhaps less popular than, say, before the War. To forbid it is absurd, and although the majority of birds are now protected by law during the nesting season, so long as the practice is carried on in moderation there can be no very great harm done. The modern boy is quick to discover, however, that a far more enjoyable and instructive adventure is that of watching birds, and then the desire to remove their eggs gradually disappears. Both these sidelines to the science of ornithology will be dealt with at greater length in later pages, but one point, which in fact concerns every branch of the study of Nature, must be emphasized at once: that is, the importance of taking notes. The added pleasure of bird-watching when a well-arranged, full note-book is kept is enormous, and anyone who intends to take more than a mere passing interest in the subject should be prepared to spend a few minutes every day writing down any observations which have been made, however trivial they may seem. Further remarks on the keeping of note-books will also be given later.



POINTERS TO BIRD PLUMAGE

In this drawing of a rook are clearly indicated the principal terms used in describing the plumage of a bird. The rook is a typical member of the order Passeriformes.

THE classification of birds is a subject of great complexity, but the main division is into flightless and flying birds. In the British Isles flying birds only are represented; they are divided into a number of "orders," some of which again are entirely absent from these islands. Each order takes its name from one typical member, and those to which our resident birds belong are, roughly, the following: (a) *Passeriformes* (Lat. *passer*, sparrow), the perching birds, which include all the true song-birds and the majority of our common species; (b) *Piciformes* (Lat. *picus*, woodpecker), the woodpeckers; (c) *Cuculiformes* (Lat. *cuculus*, cuckoo), the cuckoos; (d) *Coraciiformes* (Lat. *corax*, a crow; the roller, a scarce visitor to England, is called *Coracias* from its crow-like appearance; the true crows are passerine), including the kingfisher and the bee-eater; (e) *Strigiformes* (Lat. *strix*, owl), the owls; (f) *Accipitriformes* (Lat. *accipiter*, bird of prey), the birds of prey; (g) *Pelecaniformes* (Lat. *pelecanus*, pelican), which include the cormorant and gannet; (h) *Anseriformes* (Lat. *anser*, goose), the ducks and geese;

Woodpecker (Piciformes)

Sedge Warbler (Passeriformes) and Cuckoo (Cuculiformes)

Kingfisher (Coraciiformes)

There are more than ten thousand species of flying birds known to science, but of these only some five hundred are recognized as British, i.e., they have been found, either as chance visitors, migrants, or residents, in the British Isles. The British species comprise a number of "orders."

FAMILIAR WILD BIRDS OF THE BRITISH ISLES:

(i) *Ardeiformes* (Lat. *ardea*, heron), the herons; (j) *Charadriiformes* (Lat. *charadrius*, a yellowish bird), a large order including all the wading birds, the plovers, and similar species; (k) *Lariformes* (Lat. *larus*, sea bird), the gulls; a number of minor orders comprising the divers, petrels, and grebes; and, finally, the *Columbiformes* (Lat. *columba*, dove) and *Galliformes* (Lat. *gallus*, cock), which contain the pigeons and game birds respectively.

Specialization for Speed

As regards their evolution, the birds have a certain affinity to the reptiles, and it is considered probable that they are descended from a common ancestor; in fact, the earliest types of fossil bird-remains make this a well-nigh inevitable conclusion. Of the many indirect problems connected with the structure and physiology of birds little can be said here; it is obvious, however, that they are very highly specialized for their mode of life, which is very much more active than that of the mammals. The whole system of the bird is adapted to a high rate of life. Birds are seldom still—frequently, in the case of marine species, they spend more than half their life on the wing—and the heart of a bird beats at a far greater speed than that of other living creatures. The body temperature, too, is correspondingly higher.

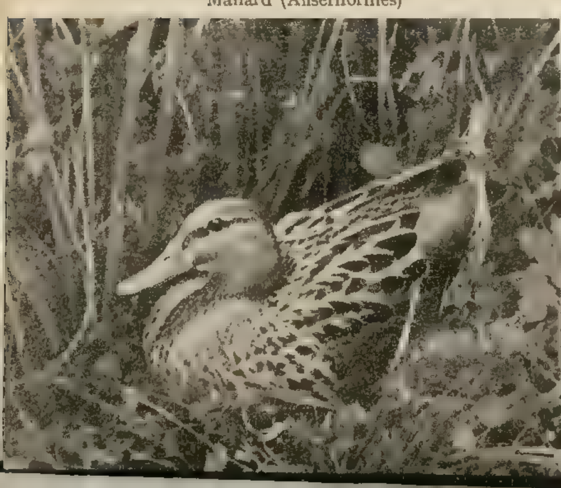
By consulting the diagram given in the preceding page the terms used in describing various parts of a bird's body and plumage will be easily understood.

Now, after these preliminary remarks, let us meet the rook, one of the best-known of British birds.

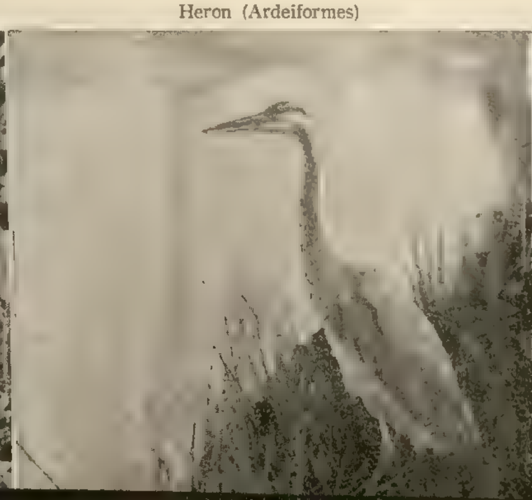
The rook has for the bird-lover an especial attraction in the early part of the year. While other less stable birds, lured on by a spell of mild weather in February or even earlier, may build and start to lay only to be overtaken by disaster, the rook waits until conditions are more sure before beginning the reconstruction of its great nest of twigs; and it is the sight of the first rook, collecting twigs for the new season, that spells "spring" to the observant countryman. A particularly sociable bird, the rook enjoys the company, not only of its fellows, but of Man, and a rookery is seldom found far from some human habitation.

The nests, made almost entirely of twigs, are perched high in the branches of some tree. No apparent preference is displayed as to the tree chosen, but one thing is certain—as soon as any tree shows signs of decay or weakness, the rooks leave it. Experience proves that their desertion of seemingly sound trees is frequently very wise, for often following the next storm after their exodus the uprooted trunks show the fate that would otherwise have overtaken them. Such a disaster does, however, provide an opportunity to inspect the nest, which, besides the sturdy twig foundation, inextricably interwoven with the branches of the tree itself, will be found to contain also a number of small sods or lumps of earth, which help

Mallard (Anseriformes)



Heron (Ardeiformes)



Green Plover (Charadriiformes)


Snowy Owl (Strigiformes)


Cormorant (Pelecaniformes)


Peregrine Falcon (Accipitriformes)

of which the Passeriformes is by far the most important. The series of pictures in this and the facing page shows typical representatives of the principal orders, and serves to demonstrate the wide range of form, structure and appearance afforded by British birds.

REPRESENTATIVES OF THE PRINCIPAL ORDERS

to make the whole structure more solid. There is a pretty thick lining of hair, grass, and other soft materials, with occasionally a little wool. The bowl of the nest is fairly deep, to lessen the possibility of the eggs being thrown out in a high wind.

The eggs are three to five in number and are of fair size, the general colour being greenish or greenish-blue, more or less obscured by a number of brown or blackish spots, especially round the larger end.

Weighed in the Farmer's Balance

Rooks pass rather less than half the year in the rookery; the greater part of their time is spent in the fields, where they are on the whole useful to the farmer, being among the principal agents in keeping down the many grubs that live close to the surface of the soil and are exposed by the plough. It cannot be denied, however, that they do eat a certain amount of grain, and may even do damage in a field of roots; and for this reason the young ones are often shot off in numbers during the early summer while they are still about the rookery.

Nesting starts, as has been indicated, about the beginning of March, but for some weeks before that time the pairs of rooks may be seen indulging in displays of courtship round the old nests, and even working in a desultory way at the collection of twigs and the destruction of last year's nests. As March goes by, activity increases, and the clamour of the rooks becomes one of the most noticeable features of the countryside. This noise, which consists mainly of an oft-repeated "caw," is not merely the conversation of a happy community; the rook is at times a most quarrelsome bird and is never above stealing a particularly suitable stick from a neighbouring nest if the opportunity occurs. As the spring passes, the shrill cries of the young, easily audible from the ground, are added to the note of the older birds. The young birds are often ready to leave the nest before April is out, and may be seen sitting on the branches near by, or making their first awkward attempts at flight among the tree-tops. As soon as they are a little more sure of their wings, they follow their parents to the nearest fields, and are fed on the spot, running hungrily after the older birds as they dig here and there for grubs and worms.

It is never very easy to approach rooks, for despite their sociability they are wary birds, but no opportunity of watching the adults feeding the young should be lost, for a point of great interest may then be observed. This is the pouch, below the beak, in which the adult stores food, and from which it is brought to the tip of the beak and then given to the young bird.

For all its apparent clumsiness and large build, the rook can be an extremely graceful bird in flight. Every morning the birds migrate in a body to the feeding grounds, returning to the rookery in the evening. But later in the year, when all the young have become expert flyers, the

Herring Gull (Lariformes)

Wood Pigeon (Columbiformes)

Grouse (Galliformes)

MAKING OLD NESTS NEW

The rook is one of the most sociable of birds, dwelling with a number of his fellows in a nest-city high in the tree-tops. Such a rookery is illustrated in the above photograph. The time is early spring, when the parent birds are busily engaged in rebuilding the nests they quitted seven or eight months before. The photograph also shows to advantage the characteristic attitudes of the birds when flying.

culprit in the centre, while a continual cawing signifies the apparent discussion of the case. The rooks then, having reached a decision, turn upon the offender, who is attacked and driven away. Since this means eviction from the community, it is in fact a sentence of death, for no solitary indiv.dual will survive long in the struggle for existence. What the offence in such a case may have been it is impossible to tell; it is, however, a rule that any sickly or obviously weak bird is ejected from a community.

In appearance the rook is at first sight a black bird, but close examination of a skin will show that it is actually a very fine inky blue-black. The plumage is of the same colour all over, but the gloss, though normally bluish, may be any colour from deep purple to a quite bright green when seen near at hand. At the time of the autumn moult, however, the birds are darker and duller. A most noticeable feature, and one which serves to distinguish it from its near cousin, the carrion crow, is the bare patch at the base of the beak, which is in fact the covering of the pouch. In the young birds this patch is coated with bristles, but after the first year it is naked and assumes a dirty whitish hue.

It may be noted that the term "crow" is misapplied at times not only to the rook but also to the jackdaw. In practice it is best to use the word only when speaking of the members of the crow family in general, or with particular reference to the carrion crow.

As far as classification is concerned, the rook is a passerine, or perching bird, and may be taken as the typical member of the *Corvidae*, or crow family. The characteristic feature of the *Passeriformes*, the foot composed of three forward toes and one at the back, is well exemplified in the rook, and its powerful voice shows the other feature, a very well-developed vocal organ.

communities from several rookeries will unite to form one large flock, and they then often roost far from their homes in some clump of trees, young and old together. In the fields they mix readily with the jackdaws and gulls that are likewise foraging for grubs. The rook on the ground is easily recognizable by its walk, a slow, not ungainly, rolling gait; the body is held erect, a quick dipping movement being made when a particle of food is to be picked up. On arriving above the field or roost, the birds dive steeply, wings half-closed, twisting and turning as they go; sometimes falling as though out of control, then flattening out and banking steeply as they reach the level of the ground or the branches.

Many stories have been told of the organization of the rook community, and it is certain that in times of stress there is a high degree of cooperation. The birds will band together in beating off an enemy, such as a hawk or other bird of prey, and there are also many reported instances of their holding so-called courts over delinquent members of their community. On these occasions they are said to sit in a solemn circle on the ground, the

WHEN TO WATCH BIRDS

It cannot be emphasized too strongly that bird-watching is more to be encouraged than bird's-nesting. It is a pursuit, too, that commends itself to the less active but more patient of Nature lovers. It is of great practical utility, for the most casual observations, carefully noted and examined, will lead gradually to the solution for oneself of many problems that at once perplex and attract the newcomer to ornithology. Many people have been brought to a knowledge and love of birds through observations made from a bedroom window while engaged in their daily dressing, and this is, in fact, an extremely good way to start. Early in the day the birds, be they sparrows in a London street or thrushes on a country lawn, are hard at work collecting food or nesting materials, and they have as yet not been disturbed by the rush of human life.

Points to Notice

Notice where the birds fly to, and where they come from. Do they return in the same direction? Are they collecting food or straw, grass or feathers? Try to make out if the birds you see are a pair, or if they are rival males, prepared at any moment to fight for the favours of the hen bird who may be near by. After a few days it will be noticed, perhaps, that one bird always comes from one direction, another from the opposite side of the area you can watch; then, if opportunity offers, see if you can find signs a little further off that may lead you to the nest. Most of our common birds are strictly territorial, and feed every day over more or less the same ground; and from this you may be sure, if you see a bird day after day, that it is the same bird and not a chance arrival.

Every fact should be noted down, until you have become used to the appearance and habits of the bird you are watching, and can recognize it with ease

ROOKERY CHEER

This "close-up" of a rook's nest shows an old rook transferring food from her food-pouch—so characteristic a feature of rook anatomy—to the tip of her beak, and thence into the open mouth of one of her ever-hungry brood

Abraham

LAKELAND SCENERY SHAPED BY VOLCANIC ACTION

Lakeland, now the placid pleasure ground of climber and hiker, was once the scene of intense volcanic activity and violent earth movement. Although these upheavals took place millions of years ago, the effect has been an enduring one upon our landscape. The igneous rocks, extruded by volcanic action, and the sedimentary rocks metamorphosed by great heat and pressure; are so hard that they have resisted the attacks of the weather and erosion by glaciers of the ice age and by rivers of much more recent times, so that they stand out today as mountain masses; the softer sedimentary rocks, however, have been

BORROWDALE VIEWED FROM SCAFELL'S SLOPES

washed down to the sea as shingle and sand. This far view shows Borrowdale stretching away to Derwentwater, with on the left Great Gable and its fellows, composed of volcanic ash. This ash, it may be remarked, is no longer soft, for heat and compression through millions of years have hardened it and weathering has completed the process. Behind Derwentwater rises the long ridge of Blencathra, or Saddleback, formed not of volcanic matter but of the famous Skiddaw Slates, an ancient clay transformed by intrusion and earth movement until it became the hard rock it is today.

STRETCHING UPWARD TO THE SUN

When growing in the open the larch, as may be seen from the photograph in page 22, assumes a pyramidal shape ; but when the trees are close together in a spinney or plantation, their lower branches, denied their share of sunlight, are stunted or die away. Under these conditions the trunk of the tree, slender and straight, shoots upwards in an endeavour to reach the sunny, open air

TREES IN GENERAL: AND THE LARCH

THE trees of Britain are among her greatest glories, whether they stand in solitary grandeur in the middle of some fair meadow or line the approach to some stately mansion, are gathered together in coppice and wood and forest, or spread themselves along the banks of meandering stream or broad-bosomed river. In our pages we shall be introduced to all the principal trees, native and exotic, of Britain, and here in the first chapter of this series we meet the larch—foreign in origin but grown in Britain since 1629 at least

FEW people, in whatever walk of life, remain completely unmoved by the sight of an apple orchard in full bloom, of plane trees in a park, or a gaunt black pine standing in lonely dignity on a windswept hillside or heath in winter-time. There is a quality, intangible and wholly undefinable, about trees that goes straight to the heart of men with a directness hardly to be equalled by anything else in Nature. The English, above all, have this tree-consciousness—not the commercially-inspired consciousness of other Nordic races, but a far deeper and finer feeling. To this fact, in particular, we owe the glorious profusion of our trees and the disorderly loveliness of our great woods; trees, and not timber, have come first in the minds of the landlords of our countryside.

Unfilled Gaps in Britain's Woods

THERE is, of course, another side to the picture. The gradual impoverishment of the land, and the rise of a generation of landowners who had neither the money nor the inclination to plant trees, have led to a tragic decrease in our forests; big woods are often in a shocking state, dead trees remaining unremoved and rotting trunks breeding innumerable pests; large areas that were cut down during the Great War have remained unafforested, and plantations innumerable have suffered from neglect and mismanagement. Gradually, however, thanks largely to the efforts of the Forestry Commission and the "Men of the Trees" society, interest has been revived, and in many parts new forests are slowly growing up to replace the old.

The demands of the science of forestry, however, are more concerned with the economic than the aesthetic aspect of trees. Though a vast forest of exactly similar trunks, devoid of their lower branches and all grown to type, may delight the eye of the forester and even have a certain limited beauty, they can give us but a poor idea of what the individual tree is like when left to itself in favourable natural conditions. Such conditions are best realized in the spacious parklands which are one of the most outstanding features of the English countryside, and it is in the parks, private and public, that our trees may be seen at their finest.

While he is looking at some ancient giant of an oak or a gnarled umbrella-headed pine, it will probably occur to the rambler that the balance of the tree is apparently very unstable. He may justifiably wonder how a single trunk can so easily support so great a weight of branches, and what is the system of roots that anchors the mass of the tree-top, even during a strong gale. Some explanation of the system on which Nature builds up a tree may, therefore, not be out of place.

It is obvious that the tree consists of root, stem, and branches, the last bearing the leaves, flowers, and fruits; and it is through the operation of these that the tree feeds and is able to grow. Through the roots the tree obtains water and such mineral salts as are necessary to add strength to its tissues; and through the leaves it obtains, from the air, the food that enables it to grow. In the air there is a large amount of the gas, carbon dioxide, and it is this that is taken in through tiny pores, known as stomata (Gr. *stoma*, mouth), in the surfaces of the leaves. By a process known as photosynthesis (Gr. *phos*, light; *synthesis*, a building-up process) the carbon in this gas is retained to be used in the structure of the tree, while the oxygen is again liberated into the air.

In the tiny seedling from which every tree is produced, the tissues, if the stem be cut in section and examined under a microscope, will be found to be roughly four in number. At the very inside there is a layer of pith, soft and porous tissue of little structural value; then comes a layer of what is called xylem (Gr. *xylon*, wood), or wood tissue, with vascular tissue (Lat. *vasculum*, a little vessel or duct) mixed with it. The vascular tissue supplies the canals by which liquids and food substances pass up the stem, and is a common feature of all plant growths. Outside this is a layer of bast tissue, which gives the inner bark, and which is itself protected by the outer bark, which is cellular. The growing layer, where cell-formation takes place by one cell dividing to form two, is inside the bast layer.

How a Tree Grows from the Inside

IN the second season of a tree's life a woody layer is formed just outside the former woody layer, while outside this, and yet inside the original bast layer, further bast tissue is formed. This layer in which growth takes place is known as the cambium. The outer bark peels off from time to time, and bast tissue takes its place, being replaced by further bast tissue from within. This process is obviously dependent on the weather, which may favour growth more at one time than another, and in the case of the broad-leaved or deciduous trees (that is, those that lose their leaves every year) there is obviously no growth during the winter months.

When a tree has been cut down, if we examine the section across the base that is left we shall see a number of very obvious rings from the centre outwards. Each of these represents one year's growth, and by counting them we can obtain an accurate estimate of the age of the tree. It is noticeable, moreover, that each ring is made easily visible by being darker and more definite towards the outside than the inside. This is because normally there are different kinds of wood produced in spring and

IN SUMMER LIVERY CLAD

Though a coniferous tree, the larch is also deciduous, i.e., it sheds its leaves in winter. Its appearance in summer is revealed above, while in the opposite page we see a larch in its winter guise.

autumn, the autumn wood being more especially developed for strengthening purposes. At the same time, through the wood at right angles with the rings there may be seen rays of a further tissue which are known as medullary rays; these are especially conspicuous in oak wood, and are one of the features to which it owes its beauty in the eyes of the cabinet-maker. In the field this is as much of the structure of the tree as we can readily observe, but a description of what may be seen when we examine a section under the microscope will be given later.

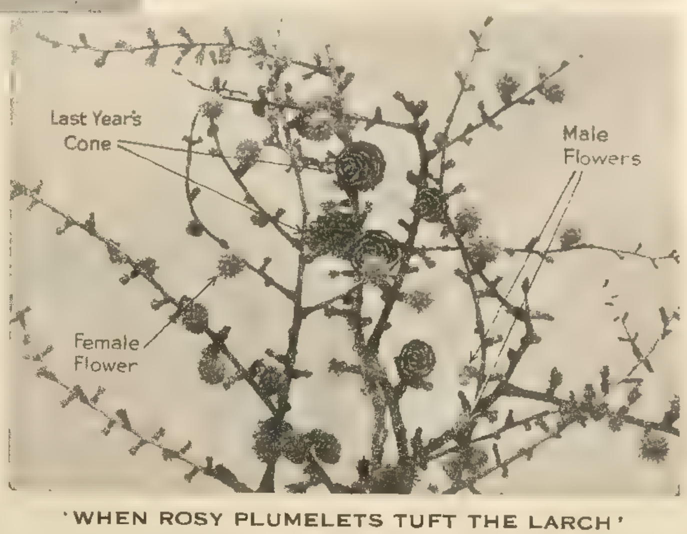
In the other direction, up the axis of the trunk, a section seen under the microscope consists of a most interesting series of cell-systems. Vessels of various types carry fluids up and down the stem; others show us by their thickened sides that they are, so to speak, the struts and girders on which the weight of the tree is supported.

The differences between the two great classes of trees, the broad-leaved, or deciduous, and the cone-bearing, or conifers, are also admirably shown in transverse sections of the trunks and twigs. The main difference is that, whereas the deciduous contain large numbers of true vessels, or pores as they may be called, the conifers are shown to be composed almost entirely of regular rays of even, straight cells, all of the same type.

The larch is perhaps the best tree to study at the outset, for, although not strictly speaking a native, it is one of our best-known coniferous trees, and is also remarkable in being deciduous. To this latter fact is to be ascribed its chief beauty—the tender, feathery sprays of palest green needles with which it brightens the hillsides in early spring. The larch was introduced into this country from northern Europe in the early part of the 17th century, and soon became firmly established, being planted to a large extent in Scotland.

Male and Female Catkins

No one who makes his first acquaintance with a larch wood in winter can imagine the change that will come over it in a few months' time. Devoid of leaves, the straight, slim trees with their pale brownish bark make one of the most mournful-looking of all woods; there is none of the dark, mysterious quality of the true coniferous forest, and at the same time none of the warmth and infinite variety of tone that characterize the leafless glades of the winter oak wood. In spring, however, the larch wood suddenly bursts into a beauty unsurpassed in Nature. From every node appears a tuft of delicate



'WHEN ROSY PLUMELETS TUFT THE LARCH'

Tennyson's "rosy plumelets" are the female flowers, well shown here in company with the male flowers and last year's cones. Another interesting feature that may be noted is the bunches of leaves sprouting direct from the rough stems.

green needles, twenty or more in number, while the warm reddish-purple of the catkins adds a lovely contrasting note. These catkins, which are sessile, i.e., growing direct on the stems, are the female flowers (for there is sex in flowers, as in animals); the male flowers, also appearing in catkins, are of a pale yellow. The female catkins give rise later in the year to small rough cones, about an inch in length; they are borne at right angles to the stems, and so usually stand vertically upright, giving a pleasing candelabra effect. These cones persist during the winter months, when they are very dark greyish brown in colour.

Shaped by the Conditions of Its Life

The trunk of the larch, when the tree is growing in the open, sheltered and free from outside influences, is tall and straight, running up to a height of a hundred feet, with a corresponding girth of as much as twelve feet some little distance above the ground. Under these conditions, too, the full beauty of form of the tree can be seen. The general outline is pyramidal, and the lower branches hang downwards a little from the trunk, turning up at their ends. This manner of growth is observed almost the whole way up the trunk, but towards the top the branches point slightly upwards, and higher still they are at a steeper angle. Where the bunches of leaves have fallen off, little knobs of bark remain, and the bark itself is very rough; the bole of the tree shows longitudinal splits, and the bark is thin and in several layers, which flake off easily.

In a well-kept forest or plantation, however, the larch assumes a very different appearance. The trees are grown close together and the lower branches die off when quite young for lack of air and light. They are cut off also by the forester to help the tree to grow clean and straight, so that the lower part of the wood consists entirely of the straight, pole-like boles, like the columns of a church, in orderly rows. Although the larch obviously loses much of its personal character when viewed close up under these conditions, it is in the forest that the trees look loveliest in spring. Then the sight of the ocean of brilliant pale green on the hillsides gives an impression of the very essence of spring and is of a colour and tone that can be found nowhere else in Nature.

Features of the Mountain Larch

There is yet another type of growth which the larch sometimes assumes, due to its property of growing in very poor soil at considerable altitudes. Happy at a height of nearly 7,000 feet above the sea, it can grow on the most barren slopes, and is, in fact, an essentially mountain tree. Thus it is that sometimes a solitary tree is found, even in this country, on the side of a bare mountain or fell, and there it is gnarled and stunted, blown to a knotted, tortured shape by the bitter winds, hardened by the mountain air and the lack of any shelter. Anyone finding such a larch for the first time might well be excused for failing to recognize it in this twisted condition.

It is an interesting fact, however, that the mountain larch, when grown in a forest, and at the same time hardened by severe weather conditions, gives a far harder and finer timber, and for that reason the timber from Scandinavian and central European trees is considered more valuable than that grown in the British Isles. The timber at its best is used for many purposes where "deal" of superior quality is required; its fine growth lends itself to telegraph and scaffold poles, while the young trees are used extensively for hop poles and in "rustic" garden work. Cut up, it may serve for sleepers and is useful in boat-building; the bark of young trees is in some parts valued for tanning. The timber reaches maturity at about forty years old. It is seldom, however, that a larch of the maximum age—about 200 years—is seen in the British Isles.

Bastin

IN WINTER BARENESS

Even though the larch has not the luxuriant verdure that characterizes such trees as the oak and elm, the difference between its appearance in summer and winter is sufficiently marked. Here a solitary, free-growing larch stands naked to the winter blasts.

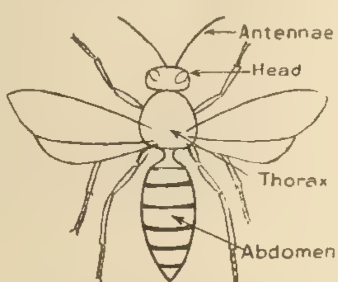
Like most other forests, the larch forest has to a certain extent its own peculiar fauna. Few plants can grow under the trees, for it is dark in summer and the small, fine needles are so numerous as to make a thick carpet beneath the trees. A species of aphis, a near relative of the green-fly found on roses, attacks the larch; and in unhealthy or diseased trees one of the wood-wasps, a large type of saw-fly, lays its eggs. The fat white grubs which result bore in the trunks and are often the cause of the mining operations of woodpeckers. All these pests attract a host of small insectivorous birds, warblers in spring and summer, and in winter flocks of tits and golden-crested wrens. As a nesting haunt the larch attracts few birds, the gold-crest and the wood pigeon being perhaps the most frequent builders in its boughs.

THE WONDERFUL WORKS OF THE WASP

THE use of a much-used—perhaps over-used—word is fully justified here, for nothing can be more wonderful, surely, than the insect polities. This series of chapters is the key that unlocks the door giving entrance to a magic world, a world in which everything save wonder is on a tiny scale. This first chapter tells of the insect groupings and of one of the most extraordinary of the insect family—the wasp

To the majority of people the term " insect " means any small, crawling, usually unpleasant and probably harmful creature, to be trodden on forthwith and so exterminated. It covers, inevitably, such things as spiders, centipedes and woodlice, and yet for some reason few people would dream of calling a shrimp or a lobster an insect. There would, however, be as much justification for this as for classing with the insects the other creatures referred to above, for spiders, millipedes, centipedes, mites and woodlice are all members of the great group of the *Arthropoda* (Gr. *arthron*, joint ; *pous*, foot), or joint-footed animals, although they are, however, members of quite different classes within the group. The principal classes are the *Crustacea* (Lat. *crusta*, shell), which contain the shrimps, crabs, lobsters and woodlice ; *Arachnida* (Gr. *arachne*, spider), which include the spiders and the mites ; *Chilopoda*, a group containing the centipedes ; *Diplopoda*, embracing the millipedes ; and *Insecta* (Lat. *in*, into ; *secare*, to cut), the insects, which derive their name from the fact that they are cut up or divided into sections.

The insects are subdivided into orders, arranged and named chiefly according to the character of the wings. The more important orders are as follow: *Aptera* (Gr. *a-*, no ; *pteron*, wing), the wingless insects, mostly minute and seldom seen, but including the common " silver-fish " found in houses ; *Orthoptera* (Gr. *orthos*, right or straight), the grasshoppers, earwig, cockroach ; *Odonata* (Gr. *odous*, tooth), dragon-flies ; *Hemiptera* (Gr. *hemi-*, half), plant bugs and lice ; *Neuroptera* (Gr. *neuron*, nerve), lace-wing flies and other insects whose wings are often remarkable for their nerve system ; and the four main groups, *Diptera* (Gr. *di-*, two), the two-winged flies ; *Lepidoptera* (Gr. *lepis*, *lepidos*, scale), butterflies and moths ; *Coleoptera* (Gr. *koleos*, sheath), beetles, and *Hymenoptera* (Gr. *hymen*, membrane), the bees, wasps and ants, so called because they have four membranous wings. There are several minor orders. The butterflies and moths are dealt with separately in this work.



THE WASP AS A TYPE

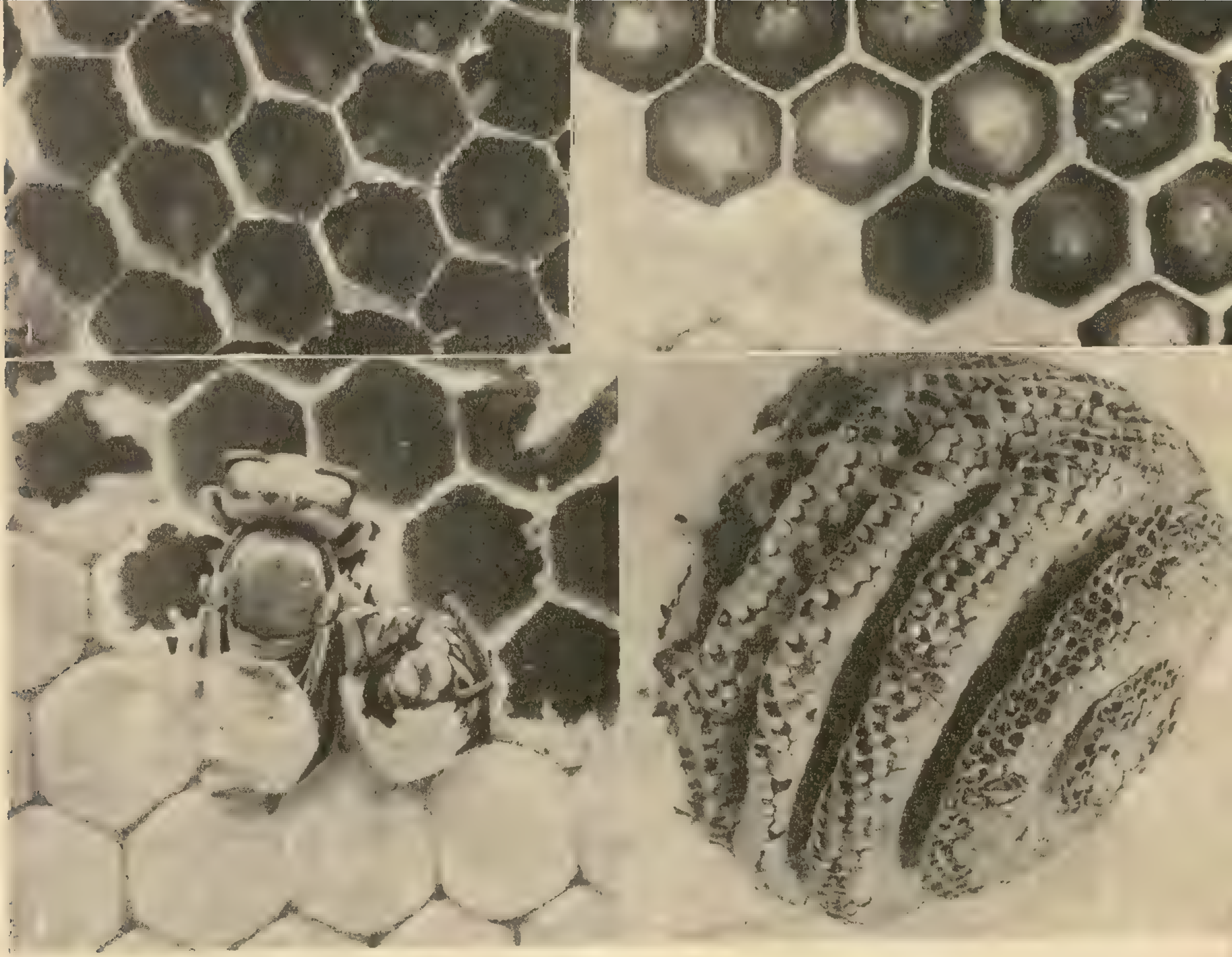
In this diagram of the wasp as a typical flying insect, note the division of the body into head, thorax, and segmented abdomen; the six legs and four wings.

As will be seen when we come to study individual insects, the life-histories of the various types differ a great deal in the separate orders. It may be said in general that there are three stages, which may be summed up as egg, nymph and adult. Of these the nymph is the only growing stage. In some classes there are *four* apparent stages, the place of the nymph being taken by the caterpillar or grub, which turns into a pupa or chrysalis before becoming adult. There has been a great deal of argument as to which of these two stages is strictly equivalent to the nymphal stage and which is a new specialization. In the simplest insects the tiny nymph which hatches from the egg is in almost every detail a small replica of the adult, and it grows simply by feeding up and then moulting until the final stage of maturity is reached. The further developments of grub and of pupa, which is apparently a resting stage, are peculiar to the higher insect groups and even within these groups are present to a varying extent. In the beetles and the butterflies and moths, for instance, the larva has to feed itself, as it does also in the flies; but in the *Hymenoptera* we find highly organized insect communities of ants, bees and wasps in which the young are brought up with great care in a safe nest, and the adults are of several types adapted to various functions within the particular community.

Many people frequently ask, how can one tell an insect ? To this there is one very simple answer ; an insect may be defined as any creature which, in the adult stage, has six legs. Many insects have more legs than six in the immature stages, e.g. some of the saw-fly larvae in the order *Hymenoptera* have as many as thirteen pairs. These are actually, however, false legs, being merely sucker-bearing projections from the body walls and not true appendages.

THE body of the adult insect is divided into three parts (*see* the diagrammatic representation of a wasp, a typical highly-developed insect). These three parts are respectively the head, thorax and abdomen, and of these the head and thorax bear a number of appendages.

In the head there are the antennae, or organs of sense, and the various small, jointed appendages known as mouth-parts. These vary considerably according to the feeding habits of the insect in question. Some insects, for instance, feed by sucking the juices of either plants or animals ; others are carnivorous ; others live on plant tissues ; others are diggers and borers in wood or in soil ; yet others, again, feed on the nectar and pollen of flowers. In essence, the mouth-parts consist of jaws or mandibles, and two sets of palps, which help to push the food into the jaws. In many cases these parts are modified to form a long proboscis or trunk, which may also be a piercing organ or sting, as in the gnats.



GENESIS OF THE WASP

1. The eggs are laid by the queen wasp on the sides of the cells. 2. The grubs grow so rapidly that they soon fit the cells. 3. Two adult wasps break through to freedom. One is almost out, the other has just chewed off its cell-cap. 4. Complete set of combs of a large subterranean nest. (1, 2, 3, about 4 times; 4, about a third natural size).

The thoracic appendages consist of the legs, of which there are three pairs, and the wings, of which there are typically two pairs—although one pair, or even both pairs, may have disappeared in the course of evolution. In the beetles and certain other insects the fore pair of wings is modified to form a shield for the hind pair, which alone are used in flying. The wing-cases are called *elytra* (Gr. *elytron*, shield). At the end of the abdomen there may be further appendages which are developed in connexion with the sex organs of the insect. These are very complicated in form and vary with every species, being often the sole means of telling the difference between two insects that would to the untrained eye seem exactly alike. (This practice of using the appendages as a means to identification may be extended very largely to the mouth-parts.) The sting found in the tail of many insects is an adaptation of the sex appendages; in some insects it serves the purpose of a boring instrument as well as that of an ovipositor or egg-laying instrument.

Communal Life of the Wasps

A MEMBER of the order *Hymenoptera*, the wasp belongs to the division known as the *Aculeata*, or stinging insects. It is in this sub-order that the insects reach their highest development, and few show the extent to which an insect community is organized better than the common wasp. Like the other social members of its class, it is found in three types: the queen, the worker or unfertile female, and the drone or male.

The solitary queen wasp is one of the few insects of its order that may be found in the early spring, for it hibernates usually indoors and is therefore often disturbed quite early in the year, especially during spring cleaning. Out of doors, queen wasps may be seen in the warm days of March, flying slowly and rather stiffly along the hedgerows and banks in search of somewhere to start their great work of nest-making. In the case of the wasps, it is the fertile queens alone that survive the winter. All the other members of a community die out at the end of the previous year, and it is left to the queens to perpetuate the race. There are in the British Isles seven species of social wasps, one of which is the hornet. The other six are all very much alike, and, in fact, are very closely related; one of them is a "cuckoo," leading a semi-parasitic life in the nests of one of the other species.

Our commoner wasps make their nests in holes in the ground or in walls or trees, but the two scarcer species build in bushes. It should be noted here that many people may be heard to say that they "have seen a wasp

READY FOR THE WINTER

At the approach of winter the queen wasp seeks some sheltered spot in which to hibernate. There she takes up her position, with wings neatly folded and legs and jaws combining to give security of grip. The white line indicates the insect's actual length.

that was so big that it must have been a hornet." Such a statement is absurd, for not only is even a small worker hornet far larger than any queen wasp, but the hornet is quite light brown and yellow, whereas all our wasps are almost entirely black and yellow. Hornets, which are actually rather confined to certain localities, almost invariably nest in hollow trees.

Now to return to the forming of the colony by the queen in early spring. We will presume that the queen in question belongs to one of the ground-nesting species, in which case, having found a suitable hole, she will inspect it closely, flying to and fro outside the entrance for some time, as though to fix the locality in her mind's eye, and then off she goes to some paling or wooden fence, where she collects wood shavings with which to begin the nest. Although we may not see the queen herself collecting shavings, the worker wasps which follow the same procedure in the summer may often be observed at work; settling in a vertical position on the paling, the wasp begins by moving its head backwards and forwards over the surface of the wood, to rasp away a fine shaving. The marks where these shavings have been removed can be seen very frequently on palings, the newly-shaved wood showing up lighter in colour. The shavings are a quarter of an inch or more in length and may be as much as an eighth of an inch wide.

The queen, going through the same performance, carries the shavings in her jaws to the nest, chewing them up to make the fine, grey wasp paper of which the whole nest will eventually be composed. It is of very great interest that no man-made paper can compare for fineness and toughness and waterproof quality with that made by the humble worker wasp in building the citadel under the earth. The first lot of paper is fastened by the queen to a root or other suitable rigid support in the roof of the hole, in a firm little lump, as the foundation of the nest. The wasp never wastes its strength or time, and on the outward journey the queen removes every time a little piece of earth so that the work of enlarging the hole goes on at the same time as the building. The foundations of the nest are not large and consist chiefly of a pillar of paper, perhaps half an inch long, hanging down from the roof of the hole. At the end of this a platform begins to be made, on which are built the first few hexagonal cells, facing *downwards*, for the whole nest is built downwards.

A little umbrella-shaped shield is formed round the pillar to protect the first cells, and when there are half-a-dozen or so of these in position, the queen lays in each one a single, oval, white egg, which is gummed to the side of the cell. She then goes on working, laying more eggs as the cells are completed, and within a week or so the first of the eggs have hatched into minute, defenceless grubs. The hard-worked queen has now to feed and rear the grubs as well as try to go on with the building. In this she has a life far harder than that of the queen bee, who is at all times surrounded by hundreds of anxious courtiers whose business it is to look after the growing family. The queen wasp herself lives for the most part on juices of plants and the nectar of flowers, but the young larvae are reared on an animal diet. There is so much to do that the queen cannot pick and choose the best food for the grubs, and any fly, grub or caterpillar of suitable size is seized, killed with the powerful jaws and chewed up into a form suitable for the young larva.

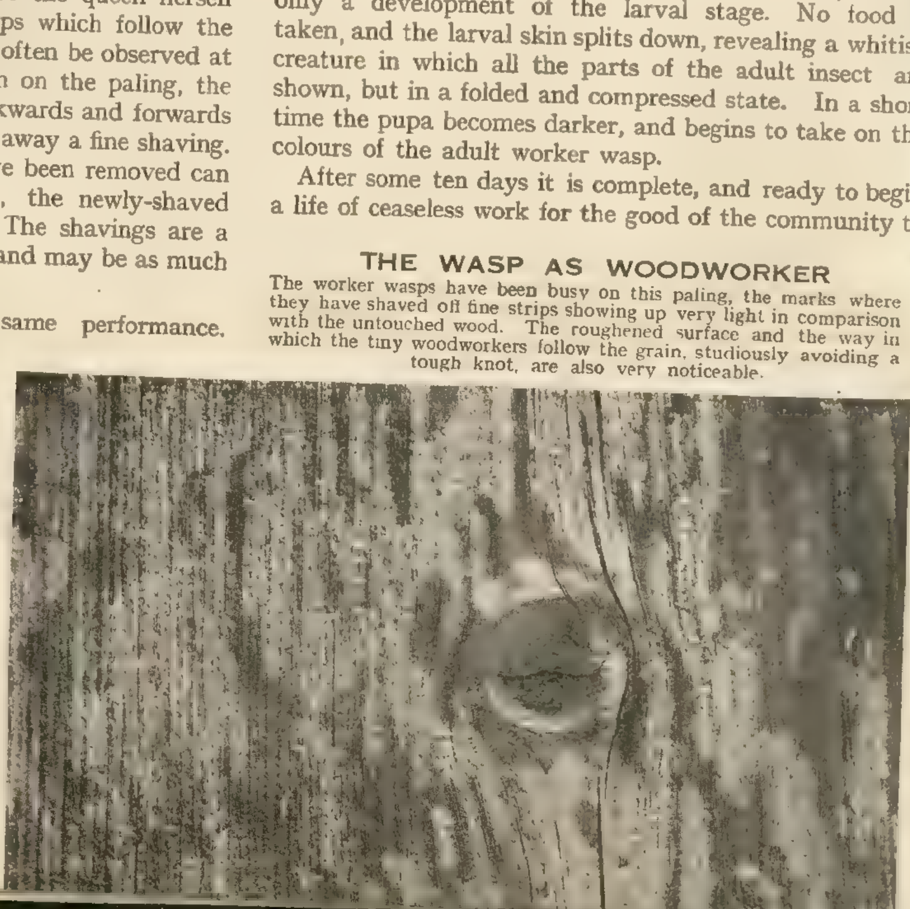
Final Stages in Wasp Development

The little grubs grow at a great rate, and within a fortnight entirely fill their cells; they then weave for themselves a cap which covers the entrance to the cell. Beneath this cap the grub turns into a pupa, or chrysalis. This is the third stage of the insect's life, though really only a development of the larval stage. No food is taken, and the larval skin splits down, revealing a whitish creature in which all the parts of the adult insect are shown, but in a folded and compressed state. In a short time the pupa becomes darker, and begins to take on the colours of the adult worker wasp.

After some ten days it is complete, and ready to begin a life of ceaseless work for the good of the community to

THE WASP AS WOODWORKER

The worker wasps have been busy on this paling, the marks where they have shaved off fine strips showing up very light in comparison with the untouched wood. The roughened surface and the way in which the tiny woodworkers follow the grain, studiously avoiding a tough knot, are also very noticeable.



which it belongs. The lid of the cell is bitten off, and the adult wasp comes out; the queen feeds the newly-emerged adult with vegetable juices, and ere long its body becomes hardened; it spends a little time in the nest, at work freeing other young wasps from their cells, and then, without any tuition and guided by pure instinct, flies out into the great world to collect food and wood shavings and make and mind the nest. As the first cells are vacated, the queen fills them with more eggs, and when a certain number of the wasps are adult and active she is at last able to retire to the nest and devote herself exclusively to the business of egg-laying.

In the meantime, the building of the nest itself has been enormously increased. The first layer of cells was stopped when it was about four inches across, and below it another was begun, supported by a series of pillars; below this, in turn, a third and further layers are similarly constructed. The original umbrella round the first pillar is extended to form an envelope that covers the entire nest with the exception of a single small entrance hole. (It may be noted that the workers cannot make a paper so fine as that made by the queen, whose original workmanship may be discovered, if a nest be examined, at the very top of the nest.) All the while the cavity is enlarged; stones which the wasps are unable to move are allowed to fall to the bottom, where they accumulate in a little pile.

CASTES OF THE WASP

The members of the wasp community—queen, male, and worker—are here shown in descending order. The queen is the largest; the male has the longest body; the worker is built on most economical lines. (About life size.)

In reality, the worker wasp is a female whose sexual organs have failed to develop, primarily as a result of poor feeding when in the larval stage; there are so many larvae that there is no time for them to be fed as well as they might be, and so their development is arrested. Later in the season, when the life of the nest is slowing up, the workers can devote more time to the feeding of the larvae, and so a number of the well-fed ones grow up and become the queens that will continue the race next year. When the workers feed the grubs they receive from the latter a certain amount of sweet, nectary saliva in exchange, so that both parties benefit. This is more or less a rule throughout the social insects, and is only another instance of the way the life of the whole colony is interwoven.

Towards the end of the season, when her ovaries are perhaps beginning to become exhausted, the queen lays eggs which are unfertilized, and it is from these eggs that the male wasps or drones are produced. The cells in which the males are being reared are somewhat longer, for the males, we find on examination, have seven visible segments to the abdomen instead of the six seen in queen and worker.

When the first frosts of autumn begin, the wasp community starts to die off, and the workers even drag undeveloped grubs out so that they shall die; only young queens are left to carry on the race, for the males, their duty of fertilizing the queens accomplished, wander aimlessly about and then die off by themselves. It is worth noting that the wasps one sees about in late autumn are mostly males, and can be handled with impunity, inasmuch as they are devoid of stings.

The wasp is hated by the fruitgrower for the havoc it may work among his plums and apples and pears; but it should always be realized that in actual fact it is more useful than harmful, for there are few such efficient scavengers, and the workers do noble work during the summer in keeping down many noxious flies and killing caterpillars that would otherwise help to attack valuable crops. One of the wasp's chief enemies is the badger, which digs out nests with impunity for the sake of the grubs, and it is interesting to note that it is parasitized by a number of flies and some rare beetles whose horny casings guard against the workers' stings.

HOW TO "SET" AN INSECT

The collection of insects is a hobby indulged in by a large number of lovers of Natural History. To the general collector of insects, one of the first and most obvious problems is, how shall he set them up in the collection? In the case of most winged insects this is a fairly simple matter. The usual way is to set them with the wings spread out flat on each side of the body. This is done on a setting board of the type that can be bought at any entomological stores. It is best to select the board in accordance with the thickness of the insect's body rather than the spread of its wings, and to choose a size larger than that which will exactly fit the insect; this will enable the legs to be set up properly.

Having pinned the insect on the setting board by means of a fine entomological pin run through the centre of the thorax, set the legs out first, and then spread out the wings carefully with a fine needle that has been fixed into a suitable handle.

Fixing the Wings

For keeping the wings in position any paper may be used, but the fine, semi-transparent type known as tracing cloth is the best; it may be obtained from any good stationer. The cloth should be cut into strips of various widths from an inch to ½ inch, and one to two inches in length. The wing is held in position with the setting needle while the strip is pinned tightly across, so that when the needle is taken away, the wing stays in the same position. One or two narrow strips are better than a single wide one.

Leave the insect on the board for three weeks or more, with a label showing locality and date of capture pinned by it; then remove it, pin the label with the same pin as the insect, and put it in the cabinet or store-case, which should be of a cork-lined pattern and absolutely airtight. When properly set, the insect should be arranged like the one in the diagram given in page 24. If there are several castes, as in the social wasps, specimens of each should be preserved. If possible, too, members of all three castes should be procured from the same nest, thus allowing a fair comparison in size and structure to be made

THE BRACKEN'S STRUGGLE FOR SURVIVAL

To the uninitiated all ferns look alike and are given the same all-comprehending name, but in actual fact there are many varieties of ferns to be found in the British woodlands, and the same may be said of fungi, mosses and liverworts which are also included under the heading of Our Ferns and Fungi. In this, the opening chapter of the series, is told the story of the bracken, whose beautiful fronds are so prominent a feature of our landscape

THE variety of fern-life known as bracken is particularly well-suited for the struggle for existence, and it is difficult for farmers living near land where "the fern" grows in quantities—in the neighbourhood of the Surrey commons, for instance, or the Yorkshire dales—to keep their fields free from invasion. Bracken advances across country at an almost unbelievable rate. One year a clover field may border the edge of the common, and only a year later the bracken may have swallowed up the field and the common encroached some seventy or eighty yards on to agricultural land. The control of bracken growth is an exacting occupation, and in Yorkshire especially the efficiency with which this is carried out is a criterion by which the farmers judge the qualities of their fellows. A really "good" farmer not only keeps his land "bracken-free" all the year round, but actually claims for himself a certain amount of "intake" each season. By perpetual cutting of the fronds and burning the ground the verdant growth, so lovely yet so destructive, is kept under control.

The exterminating process is so prolonged mainly because the really vital part of the bracken is not the green, swaying frond, but the creeping, underground stems, often mistaken for roots, and known to botanists as "rhizomes" (Greek, *rhizoma*, mass of roots). From the underside of these rhizomes a large number of fibrous roots strike down into the soil, from whence the bracken derives the salts which go to make up its food.

On examining a portion of a rhizome, it will be seen that the stalks on which the fern fronds eventually grow arise from each side of the stem. Every season at least two of these stalks send up fronds into the open air, and the remains of the stalks and fronds for several years past can often be seen. On the rhizome may also be remarked the buds for the next season's fronds, and sometimes these are developed for as many as three seasons ahead. If the farmer, in his efforts to keep pace with the advance of the fern over his land, cuts the fronds in the early summer, there are always at least two buds on each stem which have been kept, as it were, in reserve, and which now strive towards maturity to take the places of those which have been cut away.

INVADING FRONDS

One of the best-known forms of fern-life, bracken is possessed of an irrepressible vitality. Given a suitable habitat, it spreads with great rapidity and soon makes good its hold. This photo was taken in Ashridge Park, Herts, where, as in many another spot in the Home Counties, every clearing has been invaded by the coarse fern.

H. & V. Joel

Struggling Upward to the Light

IN the early spring little can be seen of the bracken other than the dead fronds of last year lying brown and rotting on the ground. With the coming of the warm weather, however, the tiny buds on the underground stems begin to bulge outwards and upwards towards the light of day, and first one and then another starts on its journey towards the sun and the warm air of summer. In April these young, curled fronds push their way through the dead remains of past years' greenery, and appear at the surface in the shape of "shepherd's crooks" of a beautiful delicate green colour, often tipped with old gold, and protected in early life with a covering of soft, brown fur. The shape of the growing frond is very well adapted for pushing itself through the soil, for the turned-down position of the head prevents the delicate, growing tip from any damaging contact.

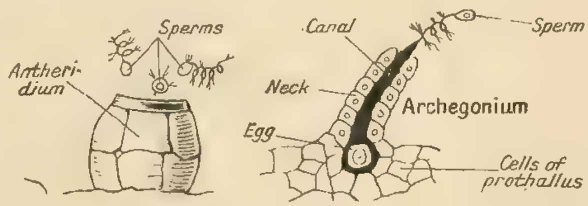
As with all plants which depend upon the chlorophyll in their leaves to supply them with food, the growth of the young fern varies according to the amount of light it receives. In the warm weather the fronds grow very rapidly. Where there is too full exposure to sunlight, however, the fronds tend to become stunted and the stems short and brittle, for ferns are essentially plants of the shady woods and deep dells, although their mode of life makes it possible for them to grow in large quantities in almost any habitat where the right soil is to be found. On the correct soil and in the shade of the woods a thick, luxuriant growth will be observed, many of the plants being as much as six or seven feet in height. Each frond is heavy with the natural juices of the plant, and owing to the amount of shade

OUT OF HARM'S WAY — *Bastin*

Carefully protected from harm by a covering of brown fur, the tip of the young bracken frond is turned down as the growing plant pushes its way through the tangled vegetation of last year.

cast by its fronds, there is little chance for other weeds and brambles to grow beneath them.

As the summer wears on, the light green changes to a darker hue, and in August and September the fronds begin to wither and bend towards the ground. This is the time for the formation of the " spores," to be found packed in millions in the shape of a fine dust in the " sori " (plural of Latin *sorus*, heap),or spore-sacs, on the underside of the frond leaves. On a walk through a ferny wood at this time of the year one's clothes become covered with this gold-coloured dust, and for many people it may mean a slight attack of hay-fever if any of the spores find their way into the nose or mouth.



FERN REPRODUCTION

Diagrammatic drawings of the male and female organs on the prothallus of bracken during the sexual process of reproduction.

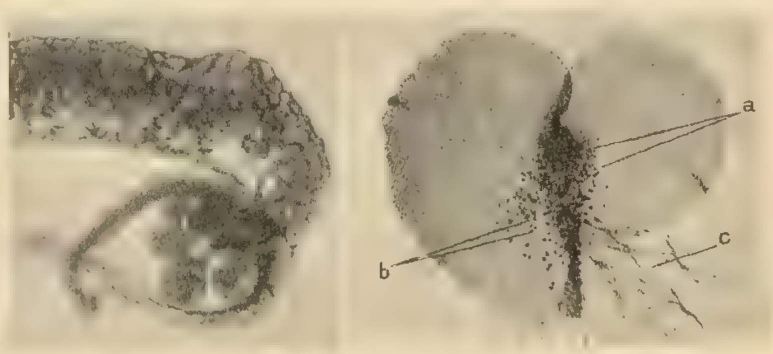
These spores are the original means by which the bracken reproduced its species, and we now come to one of the most interesting things about this plant. Although supplied with a highly complex reproductive system the bracken seldom makes use of it, relying almost entirely upon the " vegetative " means of reproduction by budding. Every autumn multitudes of spores are shed into the atmosphere of the woods and heaths, and undoubtedly the majority of them die before they are able to take root. A few, however, may find a suitable habitat on damp, sandy soil and they at once begin to grow into a flat, green body, known to botanists as the " prothallus " (Greek, *pro*, before ; *thallos*, young shoot). On this lowly green plant the actual sex organs of the fern are produced, and they appear as minute projections covering the two lobes of which the plant is composed. The female organ, or " archegonium " (from Greek *archegonos*, first of a race, original), is made up of a basal portion, situated within the body of the prothallus where the actual egg-cell is to be found, and a projecting neck. Scattered about on the same side of the prothallus, but restricted to its thinner part, are a number of equally minute and hemispherical projections, the " antheridia " (plural of antheridium, from Greek *antheros*, flowery), in which are produced the extremely small " microgametes " (Greek *micro-*, small ; *gamein*, to marry), or " spermatozoids " (Greek *sperma*, seed ; *zoon*, animal ; *-oeides*, like).

Within the archegonia a kind of slime is produced, which forces apart the cells of the neck, thus leaving a way down to the egg-cell itself. At the same time the ripe antheridia burst open and the spermatozoids are set free, and swim actively about by means of their many minute tails or " cilia " (Lat. *cilium*, eyelid, eyelash). These tiny organisms—animals they might almost be termed—are attracted to the slime of the female organs, and eventually find their way down the opened neck to the body of the egg-cell, where, by a process of fusion, fertilization takes place.

This act of union of the two " gametes " (Greek *gamein*, to marry) gives rise to the fern proper in the following year, and in the very early stages of its existence nothing can be seen at the surface of the underground life of the tiny plant. It is only after the growth of several leaves that the stem divides into two parts, one of which strikes downwards into the soil and the other up towards the light.

The chief reason why the bracken does not make more general use of this method of reproduction is that it has now become for the most part a dry-soil plant, and the growth of the prothallus cannot be carried on without the presence of damp, shady soil at the right time of the year.

Since it has these two alternative methods of reproduction, it is small wonder that the bracken should put up so determined a resistance to the exterminating methods of the farmer, for if one method of propagating the species fails, then there is always the other to fall back upon. Yet bracken is not always regarded as a pest. In many parts of the country the fern is reaped regularly, the fronds being used as bedding for cattle, and the roots dried as food for the pigs.



TWO CHAPTERS IN THE FERN'S LIFE STORY

(Left) Transverse section of a sorus (magnified 85 diameters), showing the minute spores enclosed on the underside of the leaf. (Right) The prothallus (enlarged by 8) grown from a single spore ; a, archegonia ; b, antheridia ; c, the rhizoids, or hair-like roots by which the plant is attached to the soil.

THE ROCKS THAT BUILD UP BRITAIN'S SCENERY

BRITAIN may be regarded as a political expression or a geographical division, an economic entity or a cultural complex, but in this series of chapters our island home is revealed as a huge canvas on which Nature has painted—and continues ever to paint—a picture of surpassing beauty, of unfailing interest and charm. Here will be told the fascinating story of the way British scenery has come about and is what it is

A THING of beauty, whether it be a painted canvas, a sculptured stone, or some object of exquisite craftsmanship, remains for ever with us as an even greater joy if we have some knowledge of the artist's methods, an understanding of his technique. In the same way a far deeper appreciation of the beauties of Nature may be had if we know something of the why and wherefore of our landscape. A study of science enhances our appreciation of Nature's art.

Our England is a garden. It has its hills and mountains, its farmlands cut by walls and hedges, its roads, railways and canals. The rolling downs dip into the wooded valleys where the rivers meander through to the plain. Here are great towns sending clouds of smoke into the sky, and here rocky mountain wastes, where only heather and lichens grow, and deer graze in the wind.

What made the hills and valleys? Why did the towns grow up where we find them today? Why are there lakes in some parts and only ponds in others? What is the explanation of this "Landscape of our Land?"

The answers to all these questions are comprised in the science of Geology, which is a study of the rocks and soils of the countryside. It is an old science and one of the most complete, but it is not difficult to understand.

Geology has been aptly called the geography of the past. The rocks tell also the history of the land—a history dating back far beyond the birth of Man, to the years before the very dawn of life itself.

Materials that Make up Our World

ROCKS are composed of mixtures of the various minerals, usually bound together by some matrix. These minerals, in turn, are formed by the chemical combination (not mixture) of elements. More than 2,000 different kinds, or "species," of minerals are known, but only 14 of these occur commonly. Most of them are brightly coloured, and all of them will, under the right conditions, crystallize into forms of gem-like beauty.

The simplest substances on earth are the elements, of which 90 are known to chemists; but 98.5 per cent of the minerals composing rocks on the earth's surface contain only the eleven elements: oxygen, silicon, aluminium, iron, calcium, magnesium, sodium, potassium, carbon, sulphur and chlorine. A few elements, e.g. carbon (coal), are found uncombined—not in the form of minerals at all, but as rocks of a homogeneous nature.

To be of any use, a classification of rocks must not only give some idea of the conditions under which a particular rock was formed, but it must give some indication of its composition, since these two factors together determine the structure, appearance, and, as often as not, the colour of a rock—this last being a very important factor where scenery is concerned. But all the rocks to be encountered on even the shortest of rambles can be divided quite simply into three main classes.

In the first category are grouped all those of the type which originally formed the earth's landscape millions of years ago, and which were thrust up from the depths of the earth under conditions of great heat and pressure. These rocks are known as *primary* or *igneous* rocks (Lat. *ignis*, fire). The second class includes all those strata which were deposited, and which are nearly all composed of fragments broken off from older formations and carried down by streams and rivers to seas and lakes, where they were laid down in horizontal beds. These, from the nature of their origin, are called *sedimentary* rocks, or alternatively *secondary*, as opposed to the primary formations. Thirdly, there are the rocks known as *metamorphic* or *altered*. These, through contact with igneous masses, thrust up from below, or from the effects of earth movements, are changed so as to lose their original form and mineral content.

Recognizable Features of the Primary Rocks

PRIMARY rocks may be recognized chiefly by the absence of any form of stratification and by the appearance of crystalline substance within the body of the rock. Slow cooling produces a coarseness of grain, while rapid cooling allows some of the constituents to remain uncrystallized, i.e. in a glassy state.

Primary rocks are divided into *acid* and *basic*, with intermediate varieties, those with a high silica content being called acid, while those having a small proportion of silica are known as basic.

Granite is the most typical of the British acid rocks, its pink and grey masses being a marked feature on the moors of Dartmoor and Bodmin in the West of England. As granite is a highly resistant rock, it holds the water which falls on it in the form of rain, and hence we have numerous bogs and streams gushing down the sides of the rocky highlands.

Basalt is even more distinctive, for its dark-coloured rock often forms a columnar mass, as at the Giant's Causeway on the Irish coast.

Age-old Defiers of the Weather

BUT whether acid or basic, nearly all primary rocks have one feature in common. They are hard and, therefore, much more resistant to weather than the soft sedimentary rocks. For this reason they often stand out as mountain masses in the British Isles, while their scanty soil offers little encouragement to any but the most hardy vegetation.

It should be noted that these characteristics do not always apply to igneous rocks extruded near the surface, which cool rapidly and often disintegrate easily, forming a rich soil, but such formations are rare in Great Britain.

Taylor

ON RUGGED MOOR

The hard, unyielding nature of the primary rocks makes them stand out as high country, bearing but a poor soil on which only hardy vegetation can grow. This picture, taken in the heart of Dartmoor, gives a good impression of wild moorland scenery such as is typically associated with granite.

IN FERTILE VALLEY

In striking contrast to the photograph above is this view over Buckinghamshire, taken from the village of Ivinghoe. Here is the flatter, gently-undulating country of the secondary rocks, which are easily broken up to form a rich, easily cultivated soil.

Scott

By anyone who knew nothing of geology but something of the scenery of Britain, the other primary formations could be enumerated, viz. North Wales, the Lakes (see the photograph of Borrowdale in pages 18 and 19), Galloway, the Scottish Highlands, the Wicklow mountains, the Antrim mountains, and the mountains of Mourne. All these parts of the British Isles display a similar scenery: heathered moors, lone, rocky crags, and a plentiful supply of running water.

Rocks the Rivers Have Made

SEDIMENTS consist of three main groups—the arenaceous (Lat. *arena*, sand), the argillaceous (Lat. *argilla*, clay), and the calcareous (Lat. *calx*, lime). The first two groups comprise the sandstones, shales and clays, formed from the sediments which were brought down aeons ago, when great rivers, vastly larger than any in Britain today, flowed through the countryside, their waters murky with the sediment they were carrying towards the ocean. As can be seen at any river mouth, the pebbles and other heavy material are not washed farther than the sea shore, so that beds of shingle and rocks tend to fringe the coastline. Sand and the finer particles, which eventually form clay, can travel or be carried much farther, even hundreds of miles out to sea.

The banks of sand and mud revealed at low tide at such places as Bridgewater Bay, the Dee mouth and the Wash, are the sandstone and clay deposits of the future.

Such rocks are usually deposited in layers or strata and are in consequence said to be "stratified." The reason for these strata is that the rate of deposition is often irregular and may have seasonal variations. Thus during a storm in winter a river flowing into the sea will deposit mud of a much purer nature than in summer, when the myriads of organisms of river-water life are flourishing. A winter deposit will differ in formation and composition from one laid down in summer, and will probably be thicker owing to the river in flood carrying a larger amount of sediment to the sea.

The third type of sedimentary rock is often formed from the shells of the billions of minute organisms known as *Foraminifera* which inhabit the oceans. These absorb the calcium carbonate salts found in solution in sea-water, and make them up into hard, tiny shells of extraordinary beauty. Many such shells are no larger than 1-40th of an inch across, but the organisms which inhabit them exist in such great numbers that the sediment composed of the shells of dead *Foraminifera* forms a layer of ooze on the ocean bottom thousands of feet thick.

THESE deposits, which make up the chalk and limestone of our downlands, are also often stratified, owing to the seasonal variations in the growth and multiplication of the organisms. Thus in summer, when the sunlight on which they depend for their growth is more plentiful, their rate of increase may amount to millions in twenty-four hours, while in winter, when storm-clouds shield the ocean from the sun's rays, they multiply more slowly, and the perpetual rain of tiny shells on the ocean bed becomes finer and less persistent.

Yet another group of sedimentary rocks—and economically the most important—is made up also from the remains of living things, being composed of what may be termed vegetable ooze. Vegetation washed by rivers to the sea, or submerged while actually growing, becomes, after enormous compression, what is called a carbonaceous rock, as coal or peat.

The sedimentary rocks which are to be seen today making up part of the beautiful picture of our landscape, were once nothing more than great banks of mud, shingle, sand or ooze. Through compression by the weight of rocks above, earth movements that raised them above the level of the sea and the weathering that shaped them, they have now become the hills and dales of the Cotswolds, Chilterns, the sandstone hills of southern Ireland and the West Country, the agricultural plains that occupy the centre of England and the clay on which London has been built.

Now, to sum up: when hardened by intense compression, continuing through long ages, shingle becomes conglomerate; sand becomes sandstone and grit; mud becomes shale; calcareous ooze becomes limestone and chalk; and vegetable ooze becomes coal.

When we consider what a large part of Britain is composed of flat agricultural country, rolling grasslands or wide river valleys, we get some idea of the extent of our secondary or stratified deposits. These rocks have been laid down under water, nearly always in an originally horizontal position. Later, through earth movements, igneous rocks intruded in a molten state from below, and under the influence of glaciers during the Great Ice Age they have been remoulded, folded, broken and generally changed in position or shape.

Change in the Seemingly Eternal

METAMORPHIC or altered rocks, forming the third main group, vary largely in form and composition. Firstly, they may have been either primary or secondary in origin, and, secondly, they may be changed only a little, as when a limestone is turned to a marble or a clay to a slate, or they may be altered out of all recognition as are the gneisses and schists of the north-west Highlands of Scotland, rocks which form a fundamental part of that rugged scenery.

For a start, therefore, we have a rough classification of rocks that will serve for any specimens found during a ramble in Great Britain:

TYPE		EXAMPLE
Igneous or Primary	Acid	Granite
	Basic	Basalt
Sedimentary or Secondary	Arenaceous	Sandstone, conglomerate
	Argillaceous	Clay, shale
	Calcareous	Chalk, limestone
	Carbonaceous	Coal, peat
Metamorphic or Altered	Little altered	Slate, marble
	Greatly altered	Gneiss, schist

Everyone who has travelled in Britain will have noticed the various types of scenery to be found in the different parts of the country. From what has been said above on the subject of geological formations, rocks and their origin, and with the aid of a structural or geological map of Britain, it will be clear that these variations of scenery

HARDEST ROCK OF ALL

In the Scottish Highlands are found some of the oldest formations in Great Britain—gneisses and schists which have been so altered that their origin is doubtful. This photograph, taken near Lochinver, in Sutherlandshire, shows a plateau of Lewisian gneiss, a rock whose "toughness" is a by-word among geologists.

are dependent more than anything else upon the rocks. Rocks influence, even make, scenery. Each formation has its position where it "outcrops" or appears at the surface, and each has its particular variety of scenic beauty.

The rolling chalky hills of the Chilterns were once at the bottom of an ancient sea, while the Highlands of Scotland have been thrust up from the innermost depths of the earth. The fens and broads of East Anglia differ as much in scenery and geological origin as do the bogs of Ireland and the mountains of Wales.

Soils are derived from the rocks which underlie them, and one type of soil will allow of only a certain variety of vegetation in a given latitude. Another type, coupled with a useful geographical position, will lead to the growth of a great city. An underlying stratum of some valuable rock will bring about an industrial area such as the Black Country in the Midlands. Such a region has a hard and artificial beauty all its own, but this is no less the direct result of the formation of the rocks at that point than is the loveliness of the wild country of Connemara, in the west of Ireland.

EVERYWHERE he goes the geologist has something to interest him, for his subject has so many aspects. He may read the ancient history of our land as he taps the rocks with his hammer; he may ponder on the natural formations that made Great Britain first an agricultural and then an industrial country; or, if his inclinations be artistic, he may know the reason for the beauty that delights him. For scenery, whether it strike the beholder as "beautiful" or "ugly," has for its primary cause the rocky mass of our land.

FIELD-WORK IN GEOLOGY

The chapter given above is the first of a number that are being devoted to English scenery as viewed from the geologist's standpoint, and the reader will find the interest of the subject immensely enhanced if he combines with his reading some practical field-work—if, in other words, having read about the various rocks and fossils, he goes in search of them in field or quarry, on moor or mountain or coast.

The formation of a collection of geological specimens makes a fascinating hobby, one that can be pursued independently of the weather, in any and every district, with a minimum of expense and without destroying life or in any way spoiling the beauties of the countryside.

The necessary equipment comprises a small hammer—special geologists' hammers with square heads can be obtained—a cold chisel, a pocket knife, a canvas bag to carry the equipment, specimens, etc., and a good geological map of the district. (Coloured maps covering practically the whole of the British Isles are published by the Ordnance Survey on the scale of 1 inch to a mile at 2s. a sheet covering an area of 18 miles by 12.) Then there should be a storage case—a nest of matchboxes will probably suffice for a beginning—labels, etc. A small magnifying lens is a valuable adjunct, and the amateur photographer will soon find a further use for his camera.

Collecting Rock Specimens

Fossils are not to be picked up on every hand, but rocks—and soils, remember, come in this category—are to be met with everywhere, and the would-be geologist, whether he live in town or country, is unfortunately placed if he cannot begin to make a collection of specimens on his next half-holiday or free Sunday.

At first the collection will be necessarily somewhat haphazard, for the amateur's aim will be to collect "one of everything," and not until he advances further in his study will he learn to discriminate between what look similar but are in fact very different, or vice versa.

Importance of Labelling

When the specimens have been brought home they should be placed in separate boxes and labelled with their names and the localities where they were found. Probably some difficulty will be experienced at first in the matter of nomenclature, and as likely as not mistakes will be made, but in geology as in other subjects progress is based on rectified error.

WHO'S WHO IN A WORLD OF MUD & WATER

BREATHES there the man who has not some boyhood memory of lying on a verdant bank, peering with eager curiosity into the muddy depths of some stagnant pond, peeping beneath the reeds and rushes of a river-edge and proudly bearing home, like some conquering hero, sticklebacks, tadpoles and similar small fry in jam-jars purloined from the pantry? A strange world lies hid beneath the water, and some of the personalities that comprise it are mentioned in the general survey given below

ALTHOUGH from a strictly scientific point of view it is illogical to treat the wild life of pond and stream apart from those chapters dealing with wild animals and fishes in the broader sense, it is by no means an unpopular or arbitrary division. Water-life is of interest to all, but for those whose visits to the sea-shore are limited the inhabitants of pond and stream have a very special attraction. In the stagnant pool, the small lake, or the swiftly flowing river the inland dweller of both town and country can watch with fascinated eyes the seasonal changes of the amphibian, the water insect, and the aquatic plant.

On a long country walk there is nothing more delightful than to rest for a while beside a quiet pool or slow-drifting river. A thousand and one different forms of life present themselves in the most fascinating of ways. The tall bulrushes sway in the breeze, while the tiny waves of the water's surface lap persistently on the muddy shore. A ripple on the surface reveals the presence of a swimming frog, while through the clear water can be seen hordes of freshwater shrimps, water-boatmen, snails, and larvae of all kinds.

Wherever there is a natural depression in the ground, or one that has been left by Man after digging out clay or gravel, falling rain, surface drainage, or an underground spring will eventually fill it with fresh water. Only a few days need elapse before a very little exploration will show that the hollow has become the home of quite distinct animal and vegetable communities. The speed with which this can be accomplished is in itself an astounding example of the struggle for existence and the great "housing problem" with which Nature is perpetually faced.

In these chapters dealing with the life to be found in pond and stream a number of the more fascinating forms will be dealt with in some detail. In this introductory chapter, however, brief accounts will be given of only a few of these species, so that the reader may form some general idea of the creatures and plants he may expect to encounter in this particular habitat.

Invisible spores of lowly green algae are usually the first colonizers of a new habitat, and these in the course

ILLUSORY STILLNESS

So quiet—yet beneath the mirror-like surface on which rest the broad leaves of the yellow waterlily, there swarm frogs and beetles, shrimps and snails, and many other forms of life which have found for themselves a home that suits them amid this muddy paradise

Martin

of their speedy germination give off oxygen, which becomes dissolved in the water and makes it habitable for animal life. It must be understood that fish, and indeed all creatures living in water, breathe air dissolved in the water in which they make their homes; if they are put into water from which the air has been expelled by boiling, they will drown!

As soon as the water is fit for animal habitation, insects, shellfish and eels find their way into the pool. If we look into the water we shall see swimming about among the various water weeds a water beetle known as *Dytiscus marginalis.* It is because we usually see this beetle in water that we assume, naturally enough, that it spends all its life in a watery environment; but this assumption is wrong, for the Dytiscus larva, when ready to change to the pupa stage of its life history, leaves the water and excavates for itself a little cave in the earth of the pond bank. Here it casts its skin and becomes the complete pupa, in which state it remains throughout the winter months. In the spring the final transformations take place, and eventually the perfect Dytiscus beetle emerges from the cave and plunges into the water. Besides being able to swim about in the pond the Dytiscus beetle will often crawl up reeds or on to the bank, from which, spreading its large and powerful wings, it flies off in search of fresh pools and under-water pastures new.

Cooperation of Plant and Beetle

Now here let us meet the Canadian pond weed, (*see* also p. 1037), which can be found in practically every lake, pond or slow shallow stream from Aberdeen to Penzance, although it has been present in Britain only since the year 1841, when some living specimens of the plant were sent over to a botanical laboratory at Cambridge and ultimately escaped into the river Cam. It grows so rapidly under suitable conditions that a very small piece thrown into a pond soon establishes itself and becomes a tangled growth.

Strangely enough, it is the migration of the Dytiscus, more than anything else, which has aided the rapid spread of the Canadian pond weed. The Dytiscus beetles get their legs and other parts of their bodies entangled in the weed, with the result that small pieces of the brittle stem are detached and carried away to the next pond or stream. Here the pieces are eventually washed off and begin to grow.

In the night, when the ground is wet with dew, frogs come to the pool, leaping their way slowly through the grass guided by some subtle instinct of direction. When they reach the water, they usually make it their home for at least a year, but after the spawning season of spring they very often pass on their way to a new pool, leaving the old one to their thousands of offspring.

The presence of eels in an inland pool and their previous life-history were two of the great problems which teased the minds of naturalists at the close of the Victorian era. It had been known for many years that the spawning of eels does not take place in fresh water, and it was suspected that they migrated to the sea for this purpose, especially as it was observed that vast numbers of tiny eels, or elvers, ascend our rivers in spring and the months of

VERSATILE DYTISCUS

This photograph of a male Dytiscus beetle shows the horny wing-cases thrust forward to expose the flimsy wings, outspread and ready for flight. This beetle dwells in a cave in the pond-bank, but is an expert flyer and swimmer (White line = average wing span.)

early summer. This annual movement, known as the "eel fare," is very noticeable in the Severn estuary. Two Italian naturalists eventually revealed that eels have a larval stage in their life history and that they breed only in one particular place in the world—the Sargasso Sea in mid-Atlantic. These larvae, or elvers, swim from the ocean up the rivers to the more sheltered pools inland, where they remain until sexual maturity calls them back to the Atlantic. But it sometimes happens that at night a fully-grown eel will leave the freshwater pool to which it has migrated, and wend its way overland through the dewy fields in search of another stretch of water in which to make its home.

If we dig with a stick into the mud around the margin of a pond, as likely as not we shall uncover a group of swan mussels (Anodonta), the overland distribution of which is one of the mysteries of natural history. The life history of Anodon, as this shellfish is commonly called by naturalists, has been thoroughly worked out in the laboratory and the aquarium, but at no stage of its development would it be possible for a larva either to creep across country or be carried by a bird. Part of its life is spent as a cyst in the side of a fish, and unless an inland pond happens to be stocked with these fish carrying the cysts with them, no explanation of the presence of Anodon is forthcoming.

Harpooners of the Pond World

The leaves of weeds growing in the pond will, on close examination, be seen to be covered with tiny organisms which contract themselves into minute globules as soon as one is touched or the leaf is violently disturbed. This creature is known as Hydra (*Hydra viridis*, the green Hydra). The name is that of the many-headed water monster killed by Hercules, which grew two heads in the place of each one severed by the hero, and was given to this organism because its waving tentacles make it look as if it has several heads. Some species, too, like the Hydra of legend, have the power of developing any part that has been cut off into a perfect organism. Hydra is one of the interesting inhabitants of pond waters whose life-history and general appearance are best investigated

at home where a pocket lens or a microscope can more easily be used. If watched while it is in the water, Hydra can be seen to have from eight to ten tentacles, which are kept continually on the move, as if seeking for something—which indeed they are, for it is with these tentacles that Hydra hunts and kills its food. They are supplied with tiny harpoon-like organs fitted with long hairs which act as triggers, causing the poisoned harpoon to be shot out from its concealed pocket if the feeling tentacle touches a small beetle or freshwater shrimp.

On the Trail of the Pond Snail

WHERE the fine sediment of stirred-up mud has settled for some little time, there will be seen the tracks of the pond snail, and if these are followed carefully with the eye, the actual snail which made them will probably be discovered attached to a piece of water weed or sliding gracefully over the surface of a stone. The shell of this snail is thin, horny and turreted, with an elongated spire. The animal crawls about amongst submerged water-weed, and when undisturbed, with its body fully protruded from its shell, will be seen to have a broad, short head and somewhat flattened tentacles, near the inner base of which the eyes are placed. It may at times be observed gliding along upside down just under the surface of the water, keeping itself from sinking by adhesion to the natural "skin" or meniscus which forms on the surface of all undisturbed liquids. If, however, it becomes alarmed or the smooth surface of the water is broken, it will at once sink to the bottom of the pool and glide quickly with graceful action out of sight into its protective shell.

If the pond is not one of those which is isolated inland, but is connected with other waters by a stream or even a periodically flooded ditch, the fascinating little fish known to all country schoolboys as the stickleback will probably be discovered swimming about in the water. The stickleback is in many ways a very remarkable fish and has quite a distinctive personality. In the springtime the males become very active and full of fight, and they also deck themselves out in their best and brightest clothes. Unlike any other fish of its kind, the stickleback builds a nest for the reception of the eggs or spawn.

Newts, known everywhere among country folk as "efts," are not uncommon dwellers in pond waters, and it is interesting in the late spring to watch the females depositing their eggs one at a time on the leaves of water plants. After each egg is deposited the newt folds the leaf over carefully, so as to shield the egg from observation. When the eggs hatch out, the little newt-tadpoles make their appearance, presenting a very curious figure with their feathery gills and relatively small bodies.

Varied Life in a Miniature World

THERE are usually bulrushes around the banks of the pond, and duckweed floats on the surface of the water, beneath which lie hid so many wonders, beautiful and bizarre. The pond is a little world of its own, a little animal community which we have all seen at some time or other, even though we may have noticed only a small part of its varied fauna and flora—and all of us may investigate it once again. That is why "by pond and stream" has been distinguished from other habitats and made the subject of a separate series in this work.

Revealers of Nature. 1

WHITE OF SELBORNE

IF there is one British naturalist whose name is familiar to all, he is the country clergyman who lived for nearly forty years in the quiet little village of Selborne in Hampshire. It is not for the sensational details of his life that he is remembered; he lived, indeed, remote from the busy world, untouched by the great events of his age (of which he gives not the slightest indication of having heard), and he died unknown except to his little circle of friends and correspondents. We are not sure even of his appearance, for there is some doubt about the authenticity of the portrait inserted here as being the most generally accepted. But for one book he is celebrated, and for the gentleness of character which that book enshrines.

Gilbert White, the son of a barrister, was born at Selborne parsonage—his grandfather was vicar of the parish—on July 18 1720. After schooling in the neighbourhood he studied at Oriel College, Oxford, of which, at the age of 24, he was elected a fellow, and for the next ten years he held curacies in various places in the southern counties. He settled in Selborne in 1755, and, save for visits to friends and exploratory tours of the countryside, remained there until his death on June 26, 1793. White was never, as he is commonly believed to have been, vicar or even curate, of Selborne; although he lived in its parsonage, he held cures only in neighbouring districts.

White began to keep what he called a "Garden Kalendar" in 1751, and it was about 1776 that he started writing descriptive letters to his friends concerning the interest and joy which he found in the observation of Nature. It was not until 1789, however, that these letters were collected and published as "The Natural History and Antiquities of Selborne." This book—unaffected, charming, at times humorous, and always sincere—is by universal consent one of the greatest literary classics that Nature-study has produced. Yet it has no literary arts and graces—the style is bald and unselfconscious, always informative and never obscure. It is inclined in parts even to resemble the style of the text-book, except that the reader is unhampered by profuse scientific phraseology. White possessed a literary mind, as his numerous quotations from the classical poets show, but he never allowed his personal tastes in this matter to affect the straightforward clarity of his style; it is upon the keen observation and the amiable temperament of the man himself that the fame of the book rests. After his death an old woman of Selborne summed up the village's impression of White when she described him as a kindly old gentleman who was very good to the poor and who kept a tortoise, of which he was very fond. The reader of the "Natural History of Selborne" will recognize these traits in its author, but he will be able to add to them many others of a more intimate and revealing nature. White himself also underestimated the results of his work when he wrote in his Advertisement to it:

> If the writer should at all appear to have induced any of his readers to pay a more ready attention to the wonders of the Creation, too frequently overlooked as common occurrences; or if he should by any means, through his researches, have lent an helping hand towards the enlargement of the boundaries of historical and topographical knowledge; or if he should have thrown some small light upon ancient customs and manners, and especially on those that were monastic, his purpose will be fully answered.

In that sentence alone the modesty of the man is amply apparent. Could he but have known of the thousands in every English-speaking country who, erudite scientists and ignorant readers alike, have found the deepest joy in the discovery with White of the wonders of Nature and the miracles of ordinary existence—he would not have gone on to say:

> But if he should not have been successful in any of these his intentions, yet there remains this consolation behind—that these his pursuits, by keeping the body and mind employed, have, under Providence, contributed to much health and cheerfulness of spirits, even to old age.

The reader who wanders with White about his garden and about the woods surrounding his village, who peers with him into pools, hollow trees and birds' nests, will, even if he never leaves his fireside, gain much of deep and lasting value.

THE LARGER BUTTERFLIES THAT BRIGHTEN BRITAIN'S COUNTRYSIDE

Above and overleaf are reproduced in their actual colouring, but reduced in size by about one-sixth, practically all the butterflies found in the British Isles

1 Small tortoiseshell. 2 and 3 Silver-washed fritillary. 4 Clouded yellow (female). 5 Brimstone. 6 Marbled white. 7 Large white. 8 White admiral 9 and 10 Swallow-tail. 11 Clouded yellow (male). 12 Dark green fritillary (male). 13 Peacock. 14 High brown fritillary. 15 Large tortoiseshell. 16 Purple emperor. 17 Camberwell beauty 18 Marsh fritillary. 19 Pale clouded yellow. 20 Queen of Spain fritillary. 21 and 22 Red admiral 23 Grayling. 24 Painted lady.

THE SMALLER BUTTERFLIES FOUND IN THE BRITISH ISLES

Here the smaller British butterflies are represented, in their actual colouring and about five-sixths life-size the larger butterflies are pictured overleaf.

25 Small ringlet 26 Grizzled skipper 27 Small pearl-bordered fritillary 28 Black hairstreak. 29 Mazarine blue (underside). 30 Mazarine blue. 31 Duke of Burgundy fritillary 32 Duke of Burgundy fritillary (underside) 33 Wood white. 34 Scotch brown argus. 35 Scotch brown argus (underside). 36 White letter hairstreak. 37 Heath fritillary. 38 Small white 39 Chalk hill blue. 40 Brown argus 41 Large heath. 42 Small heath. 43 Wall. 44 Dingy skipper. 45 Holly blue (female). 46 Purple hairstreak. 47 Clifden or Adonis blue. 48 Comma. 49 Scotch argus. 50 Green hairstreak. 51 Common blue. 52 Green-veined white 53 Large blue. 54 Black veined white 55 Small copper 56 Ringlet 57 Small blue. 58 Orange tip. 59 Large copper. 60 Gatekeeper 61 Lulworth skipper 62 Small skipper 63 Silver-spotted skipper. 64 Speckled wood 65 Bath white. 66 Chequered skipper (underside) 67 Chequered skipper. 68 Glanville fritillary. 69 Pearl-bordered fritillary 70 Brown hairstreak 71 Silver studded blue 72 Large skipper 73 Meadow brown

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BUTTERFLIES IN GENERAL: AND THE WHITES

To follow the gossamer-winged butterfly in flight is one of the joys which the child shares with the grown-up who has not grown too old or too blind to appreciate the sublime beauties of Nature's craftsmanship. The story of the butterfly is a fascinating one, and the chapter given below is the first of a series devoted to its telling in print and picture

THE most obvious of our insect fauna, the butterflies and moths have always attracted a large amount of attention; and though in many ways they are not more interesting than other insects, they have the advantage of being very easy to breed and rear in captivity. It is thus easy to see why not only the writers of books on Natural History but also collectors have paid far more attention to them than to the other insect groups. At the same time, it is surprising how few of our butterflies are generally recognized or are known save vaguely as "white butterflies," "blues," or "fritillaries." In this section of our work the life histories of a number of the common and more interesting butterflies and moths will be given, and the various stages will be clearly described in such a way as to assist identification and collection in the field.

As regards field work, it should be borne in mind that here, as with all natural objects and creatures, observation is to be preferred to collection, and on account of the freedom with which butterflies and moths will breed in captivity observation is especially easy. The ravages of collectors have been in fact responsible for the extinction of at least one of our native species, and others have become great rarities in localities in which they were once quite common. All collecting is not to be condemned out of hand, however, and much practical information on the subject, including the keeping of notes and records, will be given in these pages from time to time.

To the systematic entomologist, the butterflies and moths together comprise the order *Lepidoptera*, or scale-winged insects (the word is derived from the Greek for *scale* and *wing*); the old division of the order into butterflies and moths, scientifically *Rhopalocera* and *Heterocera*, is one rather of common utility than of scientific accuracy. The whole order is now divided into a number of sub-orders, of which that containing what are popularly known as butterflies is only one; the butterflies are, in fact, equivalent not to the whole category of moths, but to any one of the many sub-orders of moths. Of the latter, some of the most notable are the sphingids, or hawk moths; geometers, light, delicate insects whose caterpillars are of "stick" or "looper" type; and the noctuids, which comprise most of the short, thick-bodied, night-flying moths.

There are, however, a number of apparent differences on which the division into butterflies and moths is based: e.g. the antennae in the butterflies are clubbed (Rhopalocera is derived from the Greek for *club* and *horn*), in the moths never truly so; the body of a butterfly is usually thin, and has a waist level with the hind wings, whereas in the moths it is fatter, shorter, and more furry; butterflies fold their wings upright when at rest, so that the undersides are exposed, but moths fold them usually lengthwise, the fore-wings covering the hind ones; some moths, however, rest with their wings spread out more or less fully.

Butterflies and moths are alike in their life history, which consists of four well-marked stages: egg, larva or caterpillar, pupa or chrysalis, and imago or adult. A typical life history, and one which, from the common occurrence of the insect, can easily be observed by anyone, is that of the Large White butterfly, and this we now proceed to descr be in all its fascinating detail.

Few persons possessed of any observation, whether town-dwellers or countrymen, will be quite unfamiliar

SEEKERS AFTER NECTAR

A male and two females of the Large (Cabbage) White butterfly are here seen regaling themselves on the flowers of the knapweed; the male has no spots on the upper surface of his wings, and only one spot is noticeable on the underside. From the flowers on which they are feeding it may be told that these are insects of the summer brood, reared from eggs laid in the spring.

British Instructional Films


Ward

HOMES TO BE EATEN

Two eggs (magnified 60 diameters) of the Large White butterfly, showing the longitudinal ridges and the delicate transverse bars that strengthen the thin shells. When the young larvae hatch, these lovely shells will form their first meal.

with the Cabbage White, as it is often called, but there is a very general tendency to class together under this heading three quite distinct species—the Large, Small, and Green-veined Whites—all of which are very similar n appearance and habits, at least to the casual observer. The differences between them are actually very well-marked both in the adult and larval stages, although they are all closely related species.

THE Large White butterfly is a markedly two-brooded form, the insects of the spring brood first appearing in numbers about the beginning of May, while the caterpillars that grow up from their eggs give rise to a second generation in the late summer. The Large and Small Whites may be seen flitting about over any cabbage patch during the day-time in May, and it will be noticed that of the Large Whites, whose size is very distinctive, some have quite plain fore-wings, white with a black edge at the fore corner, while in other individuals the fore-wings have two black spots and a small black smudge. These are the females, and they may be seen from time to time to stop and settle on the lower side of a leaf. Any cabbage type of plant may be chosen for their visit, and another food plant is the nasturtium; the males, however, concern themselves solely with the flowers, on which they alight in order to suck nectar. Having settled, the females will be noticed to bend down the body and lightly touch the surface of the leaf with the tip of the abdomen. This is the process of egg-laying, and it occurs a number of times on each leaf. If the leaf is now examined, the eggs, pale yellow in colour, will be found on the lower surface. In shape they are conical, narrowing slightly at the bottom, and vertically ribbed. The ribs, about 15 in number, are joined by a number of very fine transverse ribs, which are, however, not noticeable except under a fairly strong lens. In order to study the life history closely, the leaf should be picked and transferred to a breeding cage. After a few days the eggs will be seen to have turned greyish in colour, and about a week later the tiny caterpillars will hatch out, which they do by gnawing a hole in the side of the egg-shell. Their first meal, as is the case with most lepidopterous larvae, consists of the empty egg-shell.

Cabbage for Caterpillars

FOR the first few days the little caterpillars, which are perhaps an eighth of an inch long, keep close together, often in a fan-like formation, their heads facing outwards. They are greenish in colour, the most conspicuous point about them being the large black head. Having devoured their shells, they set to work on the cabbage leaf, but at first their jaws are too weak to bite through the leaf, and only the surface layer is eaten, leaving a thin patch. If the leaf by this time is seen to be dead, the caterpillars should be carefully transferred to a fresh one; a fine paint-brush will be found the most convenient removing instrument. It may be noted here that, as a general rule, caterpillars should never be touched by hand, nor, in fact, should the insect at any stage of its career.

After a few more days several of the caterpillars may be noticed to have stopped feeding and to remain for some time stationary and in a more or less rigid position. These are in the process of changing their skins. Each one, before doing so, makes with the silk that is contained in glands near the mouth a small platform on the surface of the leaf, on which it stays during the moulting process. The number of moults varies in the life history of various species, but it is one of the features common to the development of all insects. A caterpillar that is about to moult can usually be detected by its sluggish appearance and by the fact that the head seems to be very


Hugh Main

MARCH OF HUNGER

The young larvae of the Large White keep together for the greater part of their lives, and when they have just hatched they advance steadily across the leaf, a hungry and destructive phalanx. The shiny black heads are noticeable in this picture, which shows the larvae just after they have begun to feed seriously. (About natural size.)

small in comparison with the rest of the body. After moulting, on the other hand, the head is noticeably large, and the colours of the caterpillar are for a few days brighter than normal.

For the greater part of their lives the Large White caterpillars remain in a little company, gradually demolishing the whole leaf and then moving off to another one. It is not long, however, before their jaws are strong enough to enable them to bite right through the leaf, and the damage that they do in this way may be of considerable economic importance.

Coloured Coats for Protection

After the last moult, when about an inch in length, the caterpillars separate, and their outward appearance also changes. Whereas hitherto they have been of a uniform dull green colour, they are variegated with yellow, arranged actually in broken lines along the back and sides, while the warts on the sides now appear as black spots, so numerous as to make the caterpillar a conspicuous object. Throughout their lives the caterpillars feed on the underside of the leaf, and this also applies as a fairly general rule to all caterpillars, except those that have no need of such protection as the leaf may afford. Their principal enemies are birds and certain wasps that stock their nests with caterpillars; but the fully-grown larvae are more or less immune from the latter danger. The appetite of the individual caterpillar is now immense, and where there is a bad infestation of the insect many leaves are reduced to little more than a bare midrib. In this final stage the caterpillars afford an excellent example of warning coloration; their brilliant colour scheme shows them up to any passing bird, but it appears that they have an acrid taste, and they are usually rejected by any bird that has already tasted one; in this also can be found an explanation of the fact that they feed in easily-seen companies, rather than alone. Domestic fowls, however, often eat the larvae with avidity, heedless of any taste that may put off other birds.


Ward

FIRST FLIGHT

This picture of a freshly-hatched Green-veined White butterfly shows the insect enjoying a temporary rest during its first aerial expedition. The distinctive underside, with the veins of the wings—green on a yellowish ground—is especially noticeable. The wallflower on which the butterfly is sitting is a member of the cabbage tribe—the favoured food-source of all the "Whites."


Ward

FIND THE BUTTERFLY

Sitting on the striped leaves of the coarse grass, the Green-veined White is almost invisible to any but the most expert eye, so closely does its striped underside resemble the grass blades, both in colour and design. By this protective similarity the butterfly evades the attention of its foes.

When fully grown, the caterpillars leave their food plant and wander in search of some suitable site for pupation. A wall or fence is often chosen, and in June numbers of the larvae may be found stationary, the head uppermost, on any suitable place near their food plant. Once satisfied as to the selection of a site, the caterpillar proceeds to weave a strong silken carpet—one thick pad being at the tail end of its body, and another on each side, about half-way along. It must be realized that the metamorphosis, or change, into a pupa is not a sudden one, but that throughout its life the various organs that will be evident in the adult insect have been developing beneath the skin of the caterpillar, and pupation is, in reality, little more than a moult in which the outward appearance of the insect changes very considerably.

From Caterpillar to Chrysalis

Having woven its carpet, the caterpillar is motionless for a day or two, becoming slightly smaller in length, and the head being apparently retracted within the fore-part of the body. The skin then suddenly splits along the middle of the back, and a new body is seen to bulge through; a more or less continuous wriggling ensues, and gradually the old skin is split right off, wrinkled up, and sloughed off at the back. It usually remains, a small black object, at the tail end of the pupal case. The chrysalis or pupa is at first soft and of a bright green colour, but a secretion from the skin soon hardens all over it to form a firm case. This has, in a compressed state, all the outward features of the adult insect, neatly

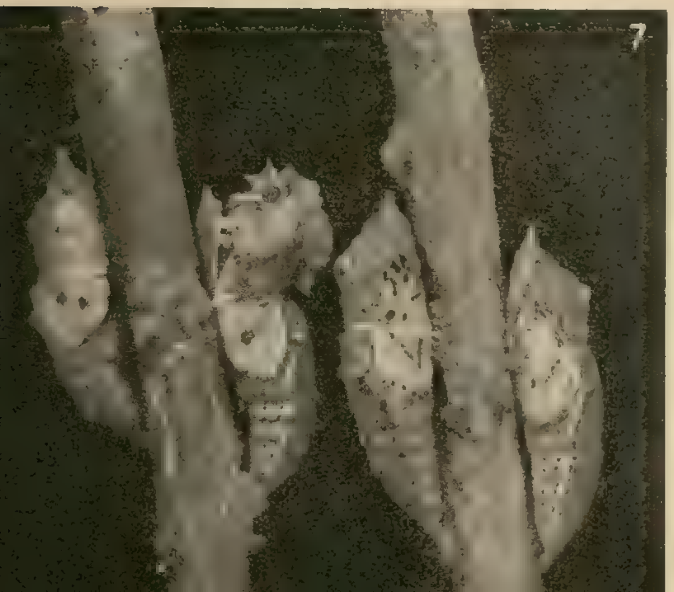
FROM EGG TO PERFECT BUTTERFLY:

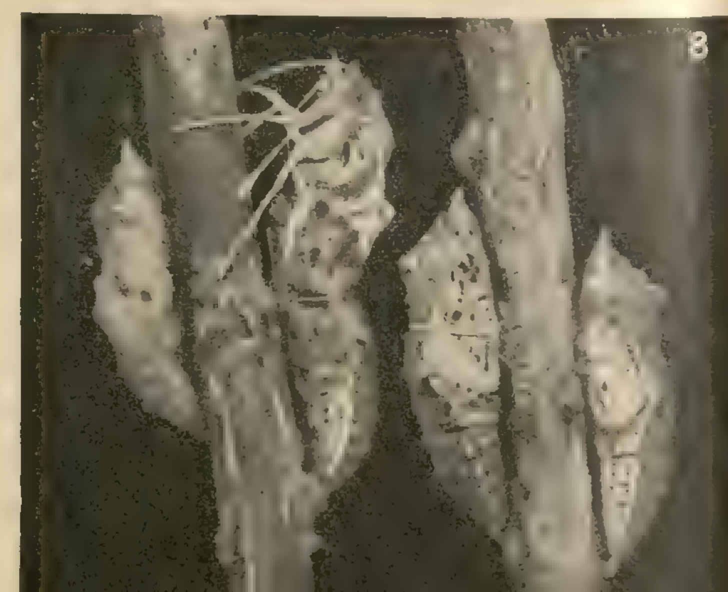
The series of photographs in this and the opposite page tell the story of the development, from egg to adult, of the Large White, one of our commonest and best-known butterflies.

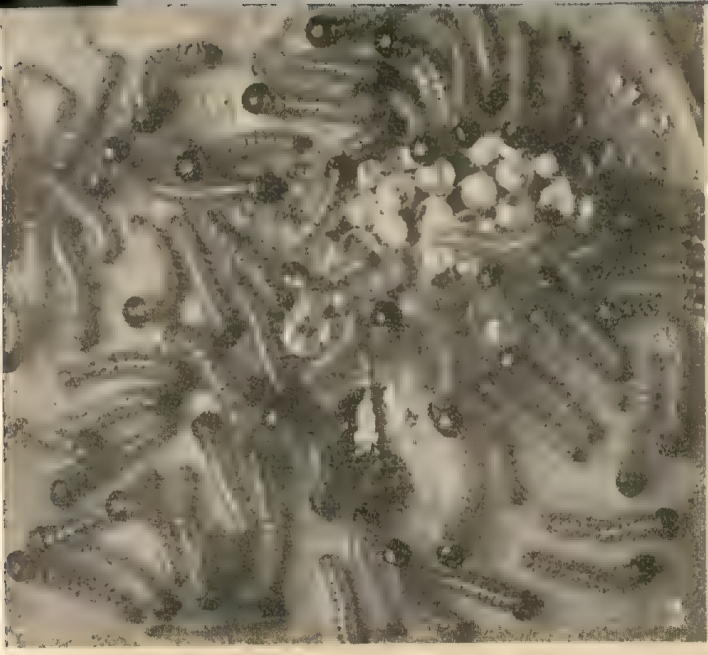
In the top left-hand photograph, the female is seen laying the eggs on the underside of a cabbage leaf; her body is curved round so as to bring her ovipositor in contact with the leaf, on which a considerable number of eggs has been already deposited. This batch of eggs is shown (enlarged about six times) in the next photograph. The eggs are covered with vertical and horizontal raised ridges, which are seen, further enlarged, in the photograph in page 38.

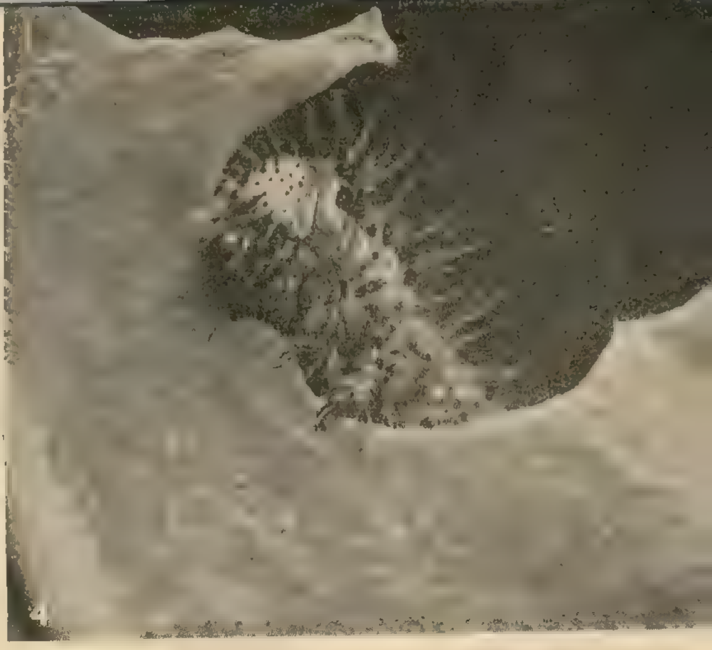
When the little larvae have hatched out from the eggs they make their first meal off the empty egg-shells—the subject of the third photograph (magnified about six times). At this stage the large black heads are the most obvious features of the caterpillar anatomy. In the Large White, it may be noted, the caterpillars keep close company for the greater part of their lives, feeding together on the leaves of the plant. Another interesting fact is that the egg-shell is usually the sole meal of a young larva in its first skin; it does not start to eat cabbage leaves until after the first moult.

As it grows, the caterpillar has an ever-increasing appetite and rapidly devours leaf after leaf of the cabbage on which it has its home. In the fourth picture, a youngish caterpillar (magnified 20 times) is seen hard at work on a half-devoured leaf. Notice the way in which the legs are used for gripping the edge of the leaf; the head is not so large now in proportion to the rest of the body, but it is still very conspicuous. The caterpillar is covered with hairs which arise from wart-like growths on the sides of the body.







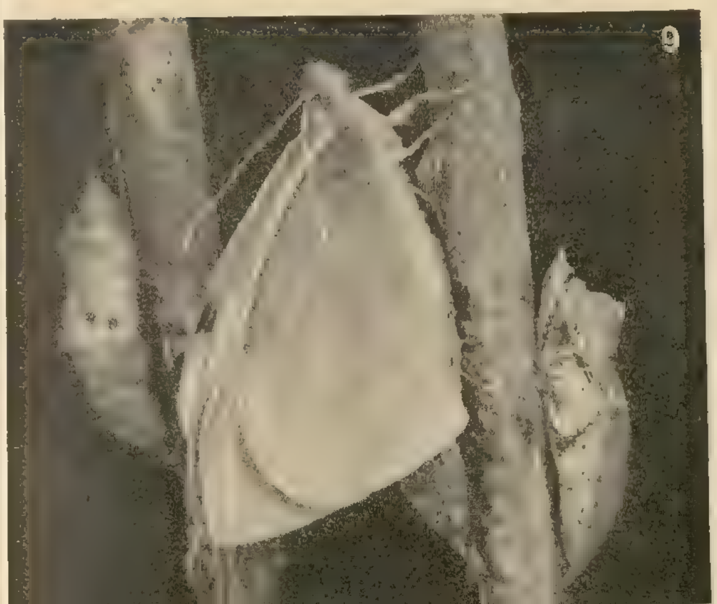


LIFE CYCLE OF THE 'LARGE WHITE'

When fully grown, the healthy larvae crawl up some object—a paling or wall, for instance, or a stick—and there weave pads of silk to enable them to maintain a firm grip. A single thread, easily visible in the fifth photograph ($\times 2\frac{1}{2}$ approx.) holds the insect to the paling. This picture also shows the way in which the skin of the larva splits up the back, so that the pupa projects through the split. The pupa then twists and turns about, until finally the skin is sloughed down to the tail, and then, with a final jerk, it is shot off to fall to the ground. In the next photo (number 6 : enlarged $2\frac{1}{2}$ times), the sloughing has taken place and the perfect pupa is now revealed fully exposed.

A number of pupae which have selected pieces of stick as suitable sites are shown in the seventh photograph (enlarged about twice). One of these, the second from the left, is starting the final stage of its metamorphosis. The back of the chrysalis has split open, and the adult insect is beginning to struggle through the split to freedom. Owing to the hard nature of the pupal skin, however, the insect has to draw itself out, as shown in the next picture (8 ; enlarged about twice), for the skin cannot be simply sloughed off as was the case with the larva skin. Having drawn itself out, it hangs motionless on the twig for some minutes, while its wings harden and dry. A preliminary flutter takes it to the next stick (9 ; enlarged $1\frac{1}{2}$ times), and it is then ready to fly away to the nearest flower bed, where, as likely as not, it will meet a mate (10 ; about natural size), and thus start again the cycle which leads to the production of a new generation of butterflies. In this final picture the male butterfly is on the left.

Photos, 1–9, British Instructional Films; 10, J. J. Ward



SEXES IN CONTRAST

1. Male of the Small White, spring brood; in the summer brood there is a black spot on the fore-wings. 2. Female of the Small White. 3. Male of the Green-veined White, spring brood; there is a spot towards the edge of the fore-wings in the summer brood. 4. The female of the Green-veined White shows the veins slightly shaded.

folded down the body. The antennae are especially obvious. At various points on each segment of the pupa are angular knobs, some of them quite sharp, and the point of attachment of the whole case consists of a sharp tip at the topmost extremity. The tongue, normally retracted in the adult insect, is represented by two long sheaths which stretch together more than half-way down the under surface of the body. The chrysalis is a fairly rigid structure, but the last few segments at the tail end can, and do, move from side to side. The colour changes gradually to a greyish white.

Emergence of the Adult Insect

THE period of pupation varies enormously in individual insects, and it may last from a few days to several months, especially as many insects hibernate at this stage. Eventually, however, the pupal case splits, and the adult insect emerges. It should at once be stated that the insect does not grow in the adult stage, and in many forms the adult does not even feed. The firm pupal skin does not wrinkle up and fall away as did that of the larva, but the adult insect has, instead, to force its way out. For this reason the wings are in a very crumpled state, and it is not until the insect has crawled, slowly and painfully, free from its pupal skin that they begin at all to assume their normal shape and appearance.

A newly-emerged butterfly is a pathetic sight; the body is large and flabby, the wings crumpled, the limbs weak and feeble, and the whole insect wet and dank. But once it has secured a firm foothold with its forelegs, so that the body can hang down free and the wings have room to expand, more changes occur—the fluids which distend the body are forced by a regular movement into the wing veins, and the wings themselves begin to expand. When the whole process is complete, the insect has a normal appearance, but it is usually some hours before it can fly. It still hangs motionless, as though feeling its way into the new life, while the wings become stiffer, stronger and, finally, dry. Then, and then only, does the fully-grown Large White launch itself into the air, perhaps to seek a mate, perhaps to be sought and in turn to begin a new generation of its kind.

MENTION has been made earlier of two other species of Whites, the Small White and the Green-veined. Of these the former is in appearance very similar to the Large White; it has practically the same wing markings, and the underside is of the same uniform greenish-yellow. In the case of the latter, however, the veins on the underside of the wings possess a very noticeable greenish colouring. The Green-veined species is only slightly less common than the other two, being frequently overlooked on account of its apparent similarity when in flight. The caterpillar of this insect, also, feeds more frequently on certain wild plants of the cabbage tribe. The Small White, too, differs in the larval stage, not only in that the caterpillars are of a more uniform green colour throughout their lives, but also in that they are solitary. Not armed with the acrid juices of their relatives, they are forced to seek safety from birds and other foes in protective resemblance; and, indeed, their dull, plain green colour makes them very hard to see on the underside of a cabbage leaf. In other particulars their life story is very similar to that told above.

Interesting experiments have been made to show how it is that the female White butterfly finds the right plant on which to lay her eggs. All the plants on which the caterpillars feed in the wild state contain a certain amount of the essential oil of mustard, and to this, it seems, the female insect is attracted. It has been found that when other plants, which were really totally unsuitable as food for the Large White caterpillars, were smeared with some of the oil, the females could be persuaded to lay their eggs on them, although if the oil were not put there artificially they would never approach those plants.

HOW TO COLLECT BUTTERFLIES

Every country-bred boy probably collects butterflies and moths, even if only spasmodically, at one time or another, but there is no reason why the town-dweller should not do so, too, given time and the necessary leisure. A word of warning, however: never start to collect unless you feel sufficiently interested to keep it up, for an incomplete, casual, and spasmodic collection means merely a useless slaughter wholly devoid of scientific value.

It is, of course, always better to observe than to collect, especially in the case of such insects as butterflies and moths, which are not so very numerous or difficult to identify in the field. However, presuming that the naturalist has decided to collect, his first care must be to have all the necessary apparatus to enable him to keep to his decision.

Net and Killing Bottle

The killing bottle is a first necessity; it should be a small glass bottle, with a good, firm screw top, and should be made up by a chemist, to contain cyanide of potassium beneath a protective layer of plaster-of-Paris. This is the standard type and any chemist is used to making them up for schoolboys and others. Then comes the net. A white net of fine muslin is the best, though some people prefer green or black; white has the advantage that it is easier to see the insects inside, and the disadvantage that it is more likely to scare the insects if waved wildly about. The rim should be collapsible and fit into a Y-piece that can go on a short handle. It may be added that the whole outfit is best bought from a recognized dealer in naturalists' requirements.

THE ARUM AND ITS WINGED ALLY

THE cooperation of plant and insect forms one of the most fascinating chapters in Natural History, and many instances of such mutually-beneficial relationship will be referred to in our pages. By no means the least remarkable of these instances is described below—the cooperation of the wild arum and certain small carrion-flies whereby the flower becomes fertilized

FEW flowers have so many country names as the wild arum or cuckoo pint. Pop lady, lords and ladies, wake-robin, parson-in-the-pulpit, Aaron's rod, ladies' fingers, priest's hood and monk's cowl—all these are names that the children in one part of the country or another have given to the same plant, and are evidence of the widespread interest that the plant arouses.

The leaves of the arum are among the earliest signs of the opening year; in February they first appear, as bright green spikes pushing upwards through the rich, loose soil in which the plant is most happy. These spikes, which come up one by one, soon unroll; the stalks lengthen to push the leaf above the surrounding undergrowth; and the leaves themselves are displayed as long, tough, dark green arrow-heads. In these first leaves we can at once find a feature of interest, for the arum belongs to a class of plants whose leaves should be parallel-veined; even a cursory examination, however, will show that there is one strong midrib, from the base of which other veins radiate to all parts of the leaf. When fully unfurled the leaves are seen to be of a true arrow-head shape, and very often they are covered with a number of purplish-brown spots and blotches.

When the leaves are more than half-way out of the soil, but frequently before they are entirely unrolled, there appears in the midst of them a lighter green spike, also tightly rolled-up. This is what is called, botanically, a spathe, and is, in fact, a part of the inflorescence of the arum. As it grows up and up the shape is fully displayed—a slightly bulbous base growing into a long, slim spike that ends in a distinct point. The spathe at this stage has given rise to the name "pop-lady," for with slight, sudden pressure from the hand it will open and unfurl with a pop. The name "lords and ladies," though usually applied to the plant at a very much later stage, is also said to have arisen from the fact that the rounded rod-like structure which is displayed when the flowers have been "popped" open is sometimes purple and sometimes yellow. The dark rods are "lords," the pale "ladies."

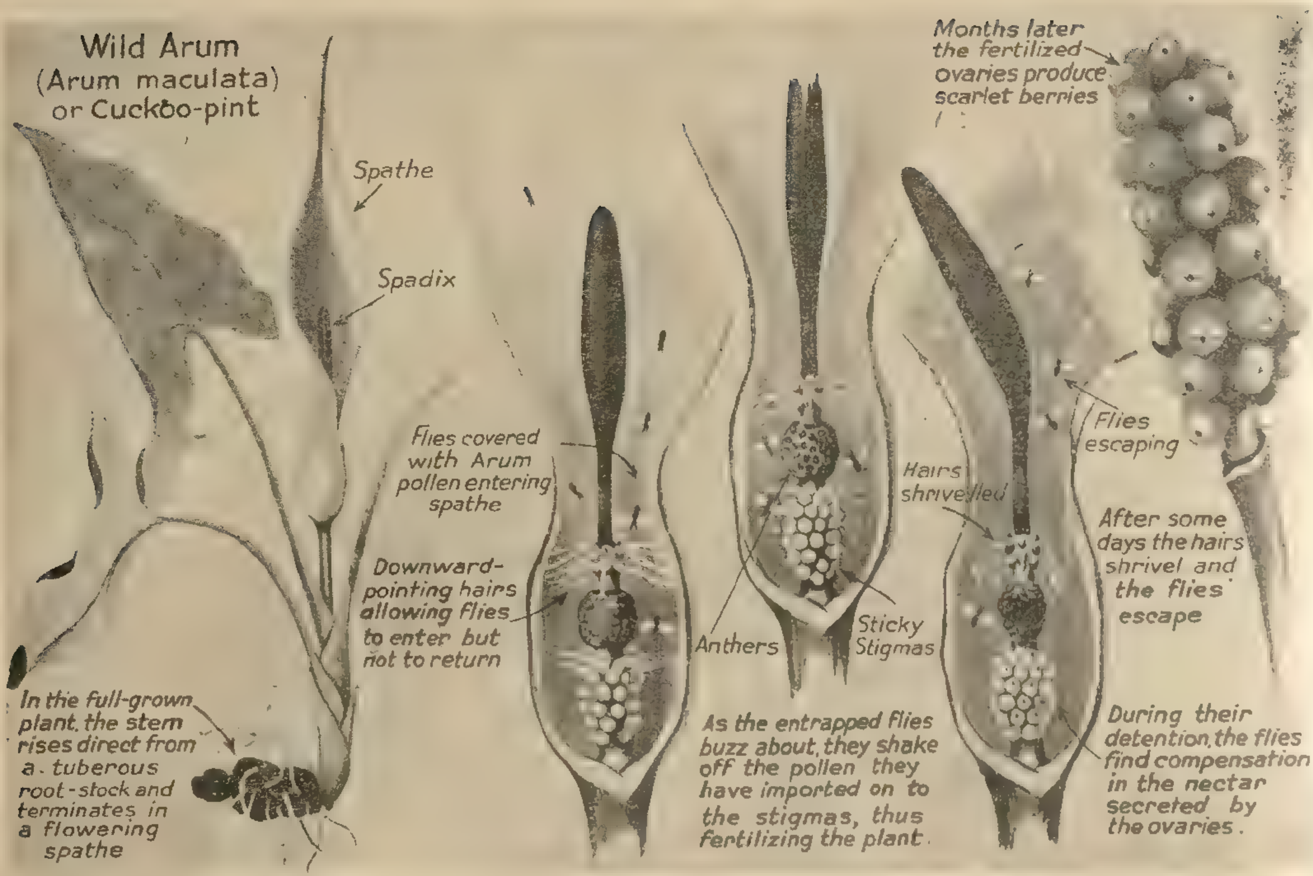
THE spathe opens gradually further and further, while the rod that can be seen from outside lengthens for some time; then it suddenly begins to wither, rolling up again and finally drooping downwards; this is the stage responsible, obviously enough, for the coining of the names "priest's hood" and "monk's cowl." Gradually the spathe dies away, with the dead rod drooping out of it, and then it falls off, leaving the base alone. Now through the ragged ends of the spathe there appears a club-shaped mass of green berry-like objects, which are in fact the seed cases. As summer goes on these swell, and turn first yellow and finally red. The leaves have died down, and the brilliant red spikes of berries, which are also known popularly, but erroneously, as "lords and ladies," are all that is left to remind us of the slim green spikes of the spring. Within that spathe one of the greatest marvels of Nature has taken place: the flowers, male and female, have grown up, fulfilled their purpose, and died down again, without ever having been even fully exposed to the light of day. And this marvel has been wrought entirely through the agency of numbers of small flies, to whose unconscious labours the arum owes the continuance of its race.

If we pick a fully-grown spathe and slit it downwards so as to leave the organs within untouched, we can see how this comes about. Up the centre of the spathe grows a continuation of the stem, which bears three distinct series of organs in rings, one above the other.

ARUMS IN FULL BLOOM

One of the most interesting of all our wild flowers, the arum or cuckoo-pint, hides its blossoms inside a leafy spathe. Three fully-opened spathes are to be seen in this photograph, and jutting up inside each is the purplish, fleshy rod or spadix which certain insects find so attractive. On the right of the picture may be noted an unopened spathe.

Bastin



HOW THE ARUM COMPELS THE CAPTIVE FLY TO SERVE ITS GENERATION

The amazing story of the cooperation of the arum or cuckoo-pint and Psychoda fly may be readily followed from this drawing. On the left is shown a full-grown arum plant. Then follow three arum spathes, cut open to reveal the sequence of events: the entry of the flies deceived by the carrion-like smell of the plant into believing that rotting carrion lies hid in the interior of the spathe—into what is in effect a skilfully-devised trap; their retention inside the spathe until they have deposited on the stigmas some of the pollen they have brought in from another arum; and their release, covered with fresh pollen, into the atmosphere, where as likely as not they soon fall victims to the unconscious guile of yet another arum plant. On the extreme right is the result of the cooperative process.

At the bottom are several whitish knobs, making a quite wide band for some way up the central spike; these knobs are the female flowers, each consisting of a rounded ovary bearing at its top the stigmas.

ABOVE these is a ring of male flowers yellow in colour and each comprising a single stamen with a plentiful supply of pollen. The topmost ring consists of a series of pale yellowish hairs, which, it will be observed (see also the above diagram), are all turned slightly downwards.

The spadix, as the whole rod is called, gives out a smell very similar to that of rotting carrion, and this attracts a number of flies which are carrion-eaters, especially those of a group known as *Psychoda*. These are small flies with wings so downy that they may easily be mistaken for tiny moths; they are often found inside the spathe when it is cut open. The top part of the rod consists of a thin column, which, opposite the opening in the spathe, widens to form the part that can be seen outside in the natural state. This column appears to be in the nature of an attractive organ, fulfilling a similar function to the brightly-coloured petals of more normal flowers. When the little *Psychoda* fly enters the spathe it is able to force its way downwards past the ring of hairs. Now if the fly in question has previously visited another arum plant, it will have collected on its body a certain amount of pollen. Once inside the arum it finds that it has been deluded, that there is no carrion, and endeavours to escape. In the insect's resultant struggle against the downward-pointing hairs a certain amount of the pollen collected from the other arum falls off and down on to the sticky stigmas of the female flowers. In this way the necessary cross-fertilization is secured. It would seem a simple matter for the pollen from the stamens of the male flowers to fall down and fertilize the female flowers below, but such self-fertilization is avoided wherever possible in Nature.

Feeding the Unwilling Guest

ONLY half of the little fly's work is done, however, for it is still unable to escape and may, indeed, be retained as prisoner for several days. During this time those of the stigmas which have not been fertilized wither, but this process is accompanied by the secretion of a certain amount of nectar by the honey glands or nectaries, which constitutes, so to speak, a reward for the fly. Meanwhile the anthers of the male flowers reach maturity and shed their pollen, not on to the female flowers but on to the back of the fly, which is still at the bottom of the chamber, as likely as not feasting on the nectar. Then at last, when the fly has, all unconsciously, been loaded up

with a fresh supply of pollen, the hairs above collapse and it is free to escape and fertilize another arum flower.

The life history of the arum, however, has further interest even when the flowering stage is over. The seeds, as has been said, ripen to form a little mass of fine red berries, very similar to those of the holly. These are eaten by birds, which, however, digest the flesh only, excreting the seeds unharmed. If they chance to fall on suitable soil, the seeds will eventually germinate, each sending a slim, sharply-pointed little root straight down into the soil.

Hard-tipped Tunnellers

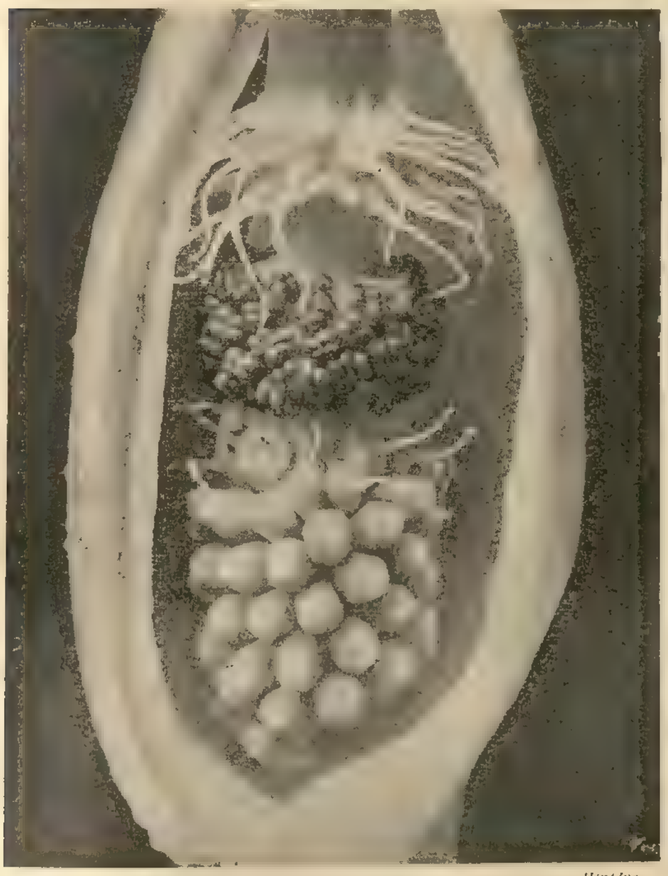
It may perhaps be wondered how the tiny, soft point of a young root can force itself through the hard soil without suffering damage. The solution to the problem lies in the fact that the actual tip of the root, known as the root cap, consists of hard cells which do not grow but which act as a sort of protective shield. Behind them come the growing cells, cells which are multiplying and increasing all the time, pushing the cap ahead of them as they go in much the same way as the makers of London's tubes employ a Greathead shield.

After descending vertically into the soil for some way the little root forms itself into a storage organ of the type known as a tuber, situated at the end of the original downward shoot. This tuber is pushed ever lower into the soil for a whole year while the roots continue growing, but no upward shoots are sent out, so that until the second season after the seed's germination there is no outward and visible sign of the new plant's existence.

Ward

AFTER THE FLOWERING

After the Psychoda flies have done their work and fertilization has taken place, the arum droops and the spathe dies off and gradually rots away. Arum leaves, it will be noticed, are arrow-shaped. (About one-third natural size.)



Hinkins

INSIDE THE FLY-TRAP

In this photograph of an arum spathe, enlarged about three times and cut vertically in section, all the parts of the curious inflorescence are clearly shown. Guarding the entrance is a ring of downward-pointing hairs; then come the male flowers, consisting simply of anthers. Below these is a ring of hairs formed from aborted stigmas, and then at the bottom of the spathe are the ovaries bearing the sticky stigmas.

The second spring, however, sees the first leaves, which are not very large or striking and which die down again in the usual manner at the end of the summer. The next year further leaves appear, larger than those of the first season, and this process continues for some seven seasons, the leaves getting larger and larger each year. Then, and then only, does the tuber, which has been growing bigger and bigger, send up the shoots which give rise to the flowering spathe.

Making Use of Arum Roots

Like many of our commoner English plants, the arum was in former times used for a number of medicinal purposes. The berries, though relished by birds, are poisonous to Man, and the acrid juices from the leaves have a very unpleasant taste. The root-tubers, however, have been recommended as making a very fine starch, although this has the disadvantage of burning the hands of anyone unwise enough to use it for laundrywork.

As a garden flower the arum is scarcely known, but one of its near relatives is the lovely arum lily that flourishes

Bedford

'LORDS AND LADIES'

Late in the year, when much of the lush vegetation of the hedgerow has died down, the seed-bodies of the arum, now a cluster of brilliant red berries, constitute a splash of conspicuous colour against the browning background. It will be noticed that the spathe, formerly so prominent, has now quite rotted away.

in hothouses and is used for decoration. Though far more beautiful than its wild cousin, the arum lily is a much less interesting plant to the naturalist.

The arum is one of the commonest members of the great class of the monocotyledons—that is, plants in which the young seedling has only a single embryonic leaf when it first appears through the soil; the other class, the dicotyledons, have two embryonic leaves. Other points of interest about the monocotyledons are the structure of the stem, the venation of the leaves, and the manner of growth of the whole plant.

The stem of the typical monocotyledon is composed of woody fibres, often extremely strong and tough; ordinary cellular tissue; and spiral vessels for the conduction of the food and drink of the plant. Both bark and pith are absent, and the arrangement of the wood in concentric rings, so marked a feature of the dicotyledonous trees, is not found in this class. The stem grows by increase of the cells on the inside—from the centre outwards—and not from a special growing layer near the outside, as it does in the dicotyledons.

In most cases the stem also terminates in a single bud, from which growth takes place, and normally there are no buds at the nodes where leaves are given off. The stem may be hollow. The leaves are typically parallel veined, but the arum provides an exception to this rule.

Petals are very frequently absent from the monocotyledonous flower, and when present they are usually three in number. The parts of the flowers, in fact, are always arranged in threes or in multiples of three.

Although this class is not especially well represented in the British Isles, it supplies a very large proportion of the plants of the tropics, and many of the plants and trees most valuable in commerce are members of it. So far as we are concerned, the orchids, the lilies, the daffodil and its relations, and the grasses are the chief representatives of this very numerous and important class.

HOW TO PRESS FLOWERS. 1

For anyone who wishes to take a permanent and intelligent interest in flowers, the problem of collecting must sooner or later arise. In this respect there is no substitute for the old method of drying and pressing flowers and keeping them in what is known as a herbarium. Before learning how to press flowers, however, it is as well to be able to collect them in the way most likely to keep them fresh while they are being taken home.

It is best always to select a specimen that will fit the mount easily and will show flower, stem, leaf, bud, and, if possible, fruit, in the one plant. Flowers should not be carried in a bunch in the hand, but a long, oval basket or special collecting tin (such as is illustrated in the adjoining column) should be used. A trowel is useful for small plants in which the root also may be collected. If a plant has leaves of more than one shape, specimens of each should be preserved.

Refrain from Picking the Rare

If a rare plant is found, the collector should resist the temptation to pick it and content himself with a note of the locality or, at most, a single flower, perhaps, may be picked for his collection. All too frequently the unthinking eagerness of the collector has prevented some rare plant from re-establishing itself in old haunts, or from extending its range to new ones.

Flowers should not be left long in water before they are pressed. Some will keep fresh for hours, while others droop very quickly, and others, again, close their flowers and will not open again in water. Such plants should be pressed the moment they are plucked.

A botanical press is easily made. It consists of two boards, ½ in. thick and the same size as the mounting papers—about 12 in. by 9 in. is a useful size. Between them lie sheets of botanical drying paper or good white blotting-paper, slightly smaller than the boards. A couple of stout straps complete the press. A rather more elaborate press is shown in the photograph below. It consists of a wire frame—hence its lightness and portability—and the straps which fasten it help to press the flowers within.

For mounting the dried flowers, sheets of mounting paper are best used. Drawing paper or strong white cartridge paper makes a good mount. If loose sheets are used they must be stored out of the dust, and small chests of drawers can be obtained quite cheaply for the purpose. For mounting, photographic paste is the best but home-made paste, if not too thick, stickphast, or gum can be used. A little

transparent adhesive tape may be needed, and a few naphtha balls should be kept with the mounted plants.

CHANGEABLE FACTORS IN BRITAIN'S CLIMATE

THE vagaries of our weather are a conversational commonplace amongst us, and not even the most experienced of meteorologists can be safe in prophesying since the factors making for change are so many, so varied and powerful. However, in the series of chapters of which the first appears below, we shall give the facts on which weather predictions are based, as well as a mass of miscellaneous weather-lore of theoretic interest and practical importance to dwellers alike in town and country

AFTER a typically English week of rain and overclouded skies the sun may suddenly burst through with the coming of dawn, and cast a golden glow over the damp and steaming countryside. The birds will sing more loudly in hedgerow and wood, while on a walk through the fields and lanes many a form of life will be seen which during the rainy days had been almost forgotten. On such a morning as this no one will hesitate to remark on the loveliness of the English weather. Then in a few hours, perhaps, the rain comes again or the temperature suddenly falls; once more the weather is the topic of conversation, but this time the adjectives used are " horrible " or " foul."

The English weather is famous all over the world for its variability, and sometimes we are given to believe that of comparatively recent years it has taken a turn for the worse. Most of our ideas as to what constitutes the real old English weather, however, have little basis in fact, but are mainly derived from the experience of continental countries, where in reality the conditions are completely different. Cold, hard winters and blazing summers are typical of continental countries, and not of an island such as Britain; the snow-clad scenery of Christmas cards is a myth so far as England is concerned, for if snow falls in this country to any considerable extent it does so in the months of January and February, and rarely before the beginning of the new year.

Sea's Influence on British Weather

BRITAIN has, in fact, what is known as a maritime climate, which in non-technical language may be described as " seaside weather " ; it is to the presence of the sea that Britain's highly temperamental and changeable weather is to be ascribed. Although it may seem surprising to some readers, Britain's temperature throughout the year is subject to only slight variations—slight, that is, compared with the conditions in the middle of a great land-mass, such as Europe or Asia, where the moderating influence of the sea is absent, and the variation between the average winter and summer temperatures is very considerable. We invariably associate a Russian winter with banks of snow and rivers frozen over with many feet of ice, but in England snow is a subject for headlines in the press, and the Thames freezes over about once in every hundred years. As everyone knows, it often happens in Britain that in late November there are days when the sun shines as if May were back once more ; then before the month is out frost covers the ground, and skating may be in progress on every pond and shallow lake. Such sudden changes—disconcerting, no doubt, but affording always a very welcome stand-by in everyday conversation—are not possible in the middle of a great continent, where the large masses of 'and give rise to temperatures which, though they are more constant, are also subject to wide extremes.

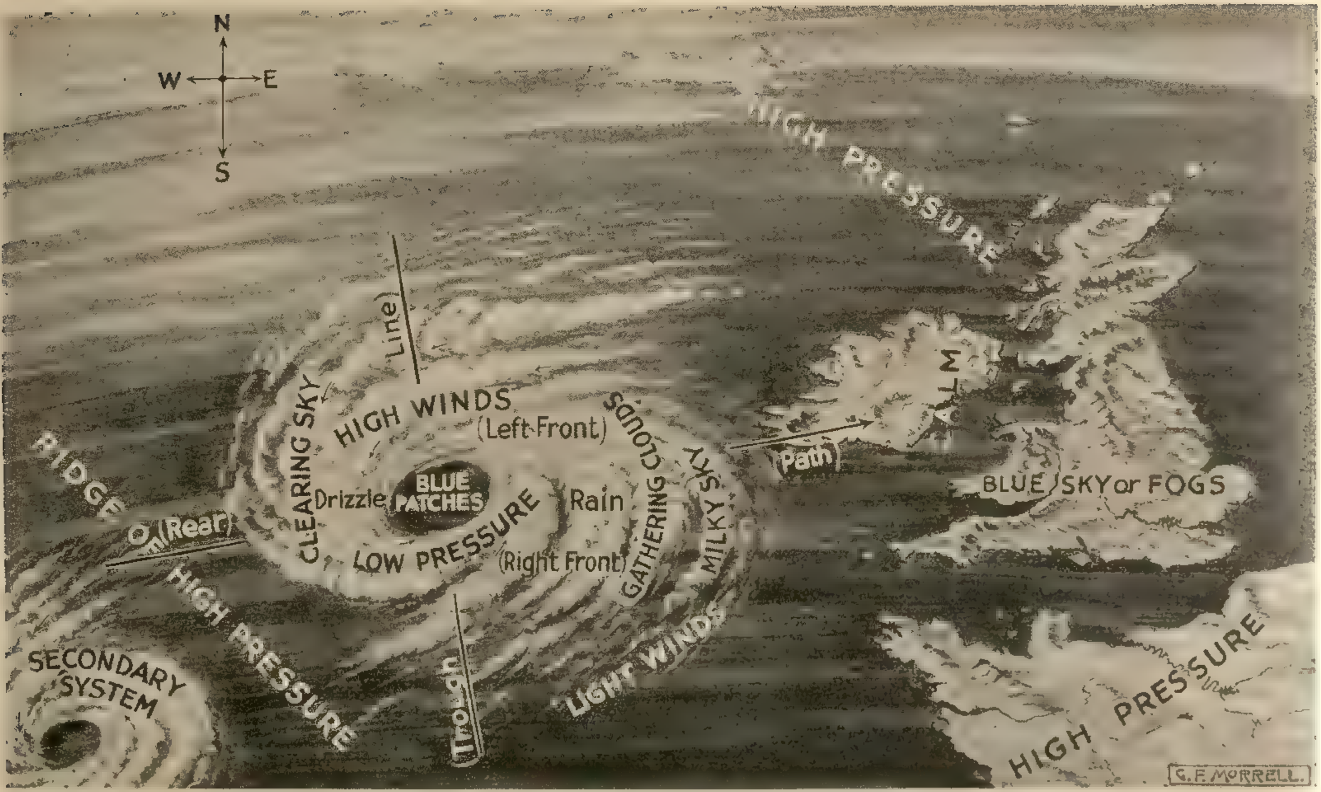
It is the presence of the sea around our shores that keeps the temperature of the atmosphere within certain narrow limits. Land absorbs heat and restores it to the atmosphere far more quickly than water, so that, if heated in summer, it may become exceedingly hot for long periods and during the winter may be exceedingly cold and frost-bound. Water, on the other hand, takes a very considerable time to change, and, if heated in summer and cooled in winter, tends to assume a temperature midway between the two extremes. It is this half-way temperature of the waters of the surrounding ocean that controls the weather of Britain.

Moderating Currents of Air and Water

THERE are, however, two other very important factors affecting our weather—the currents of water and air. An air current is known as a wind, and the fact that the prevailing winds which reach our shores blow from the south-west also tends to moderate the temperature changes, for these winds must pass across the whole of the North Atlantic Ocean before they reach us, and are therefore not only influenced by the moderate temperature of the water, but are heavily charged with moisture. This humidity of the prevailing winds is largely responsible for our damp climate.

The great water current known as the Gulf Stream flows across the Atlantic, also from the south-west, and brings with it vast volumes of water which have flowed from the tropics into the Gulf of Mexico and out again, up the east coast of the United States and then across to Ireland. The Gulf Stream undoubtedly plays a very large part in raising the average yearly temperature of the British Isles—and not only of Britain, for its influence is felt also in the Lofoten Islands off the north coast of Norway, so that people living hundreds of miles south of these islands go north in summer for the warm weather which the Gulf Stream brings with it.

WESTERLY winds do not blow steadily all the year round. Their persistency is interrupted by the presence of relatively small wind systems situated, as it were, within the body of the general flow of air. These systems can be divided into two kinds, those of higher and those of lower pressure than the average. An area of low pressure in the atmosphere brings about the production of what is called a *cyclone* (Greek *kuklon*, moving in a circle), while a region of high pressure is known as an *anti-cyclone.* These two systems are responsible for wet and fine weather respectively, and it is the alternation



'DEPRESSION OVER THE ATLANTIC': THE CYCLONE SYSTEM

In this diagrammatic drawing a cyclone is seen approaching the British Isles from the south-west, while a ridge of high pressure divides it from another secondary system situated over a more distant part of the Atlantic. As the depression passes overhead, the sky has at first a milky appearance, while on the far horizon clouds are gathering. Soon heavy, wind-driven rain will fall, and somewhat later, when the centre of the depression arrives, patches of blue sky will be observed between the flying clouds. With the coming of the rear of the system, more rain will fall, until finally the high pressure ridge brings with it fine weather once again.

of cyclone and anti-cyclone that gives rise to Britain's world-famous variable weather.

The atmosphere is a gaseous envelope covering the world to a thickness of about two hundred miles; it consists of a mixture of about 79 per cent nitrogen and 21 per cent oxygen, though other gases (carbon dioxide, for example) are present in extremely small quantities—also water vapour and solid particles of dust. It is to these dust particles, by the way, that we owe the blue colour of the sky, for they act as a light filter, scattering the red light and allowing a greater quantity of blue to pass through to the earth.

The atmosphere is heated by the sun, receiving its heat, not from the direct rays, which pass through it, but from the dark or reflected rays given off from the earth's surface. Accordingly, the lower strata of the atmosphere become heated most, and the temperature falls as one passes from sea level to higher altitudes. It is well known that hot air rises, and it is a fact that hot air can hold more water vapour than cold. The lighter, heated air near the earth's surface tends, therefore, to drift upwards, and if one spot on the ground is heated more than the surrounding area, the air above that spot will rise above the air about it. In this way is produced a column of air higher than all the surrounding columns.

THE air at the very top of this column, about two hundred miles above the earth's surface, will flow outwards in all directions until equilibrium is restored, in just the same way as water will flow from one vessel to another at a different level. Owing to this overflow the columns of air around the central and taller column will contain more air than formerly, and will therefore press on the earth's surface with a greater force than before.

Thus is caused a small area of low pressure set in the midst of a ring of high pressure. It is clear that such a state of affairs will not endure for long, for the air in the high pressure area will tend to flow inwards towards the low pressure area in the centre. The system cannot be said to be in perfect equilibrium until this flow of air is completed and the pressures are the same in both areas. Such a low pressure system surrounded by a ring of high pressure systems is known as a *cyclone* and brings with it storms and rain.

Winds and the Revolving World

GENERALLY speaking, the tendency of air is to flow upwards and outwards in the higher regions of the atmosphere from areas of low pressure to areas of high pressure, and downwards and inwards in the layers immediately overlying the earth's surface. These latter movements are those which specially interest us, since they represent the winds which we meet with every day.

If the earth were stationary, these movements would be in straight lines, but owing to the earth's rotation they are really spiral. The earth is rotating from west to east, and the air just above the ground is carried round with it. A point on the equator performs a journey of about 24,000 miles every day, and the same is the case with a particle of air just above it. A point at the poles, on

the other hand, is stationary, and points situated between the poles and the equator perform journeys of greater and greater length as the equator is approached. Picture a particle of air moving in a northerly direction from the equator, where it is travelling at the rate of 24,000 miles a day. It will, as it moves north, come into contact with particles of air moving at slower and slower speeds, but will, of course, retain some of its original velocity from west to east and will, therefore, tend to drift in an easterly direction. Instead of reaching a point due north from where it started, it will end its journey considerably to the north-east.

In the same way a particle moving south from the north pole will arrive at a point west of the longitude at which it started its journey. In the northern hemisphere air moving in any direction other than due east and west will be deflected to the *right* of its course. Conversely, it will be found that all winds in the southern hemisphere are deflected to the *left*. In low pressure systems in the northern hemisphere the winds flow spirally downwards and inwards in an anti-clockwise direction, while in the southern they move clockwise.

Anti-Cyclonic Air Movement

An *anti-cyclone* is a system of winds which blow spirally outwards from a centre of high pressure to regions where the pressure is lower. In this case the direction of the deflection is reversed, and they blow spirally clockwise in the northern hemisphere, and spirally anti-clockwise south of the equator.

The speed of the winds of a cyclone is usually very much greater than that of the winds of an anti-cyclone, and accordingly cyclones are often accompanied by gales and storms and anti-cyclones by calm. The centre of a wind system is not usually stationary for any length of time, but has a more or less definite path. In the case of Britain this is usually from the south-west to the north-east, and we therefore often read of cyclones approaching our shores from the Atlantic.

Telling the Weather from the Sky

The type of cloud seen in the sky is largely dependent upon the nature of the prevailing wind system. An anti-cyclone is marked by quiet weather; the long, dry spells in summer, the prolonged fogs of autumn, and the frosts of winter occur during the prevalence of anti-cyclonic conditions. Clear skies or fogs are frequent, but if the sky is cloudy we find a haze around the horizon. Anti-cyclonic conditions are those we most hope for when we go away for a holiday, but they are by no means the best for scenic effects. In mountain regions during an anti-cyclone beautiful views may be obscured by haze for days on end.

The passage of a cyclone is marked by a definite relationship between the types of cloud seen overhead and the portion of the cyclone passing at the moment. In front of an advancing cyclone gossamer-like threads of cloud are first seen at a great altitude, but these soon thicken out into a milky mass of vapour. This milky appearance is followed by the rain clouds, and the very

'HIGH PRESSURE OVER BRITAIN': THE ANTI-CYCLONE SYSTEM

Here the artist has pictured an anti-cyclonic area of high pressure situated over the north-eastern Atlantic and embracing the whole of the British Isles. Very considerably larger than the cyclone shown in the opposite page, the whole system moves more slowly and the weather conditions prevailing will continue with "no change" for a much longer period. Winds will be light and variable, except on the outskirts, where the sky may be slightly cloudy and the wind stronger. In winter fogs and frost will occur on land and off the coast, but in summer a heat-wave might be expected, its duration depending on the speed and the direction of the system's path.

the pressure at the centre and that at the line of depression may be very great, and the "pressure gradient" is then said to be steep. If, on the other hand, the depression is very large and the difference between the pressures only slight, it is said to be shallow, and the gradient is described as gentle.

It is extremely interesting to follow the gradual change from one stage to another in the history of a passing wind system, and such cloud-watching, especially if it be

STORM HARBINGERS
The sailor's dreaded "mackerel sky" is seen only before the coming of a small, fast-moving cyclone, which will bring very rough weather. The small size of the system can be gauged from the proximity of the outer fringe to the dark rain clouds seen at the bottom of the photograph.

WET WEATHER SIGNALS
On the very fringe of a cyclonic system, white wisps of cloud at an altitude of some 30,000 feet appear streaked across the clear blue of the sky. These are the "mare's tails" of the old sailors.

centre of the cyclone is marked by alternate patches of blue sky and broken cloud. In the rear of the system we find few rain clouds, but, in the main, such high and patchy masses of vapour as were observed in the front.

The Hon. R. Abercromby, who carried out numerous experiments in meteorology, used a very definite nomenclature for describing the various parts of a depression. The very front of the system is referred to technically as the front, and the left and right sides as the left and right fronts. The back is called the rear, the outside rim the line of depression, and the general direction in which the cyclone moves is the path. An imaginary line drawn at right angles to the path, through the centre, is called the line of trough. If the cyclone is a very small one, the difference between accompanied by an understanding of the natural forces at work, will often add an interest to a country ramble which would otherwise have been spoilt "because of the rain."

HOW TO MAKE A BAROMETER

Cyclones, or centres of low pressure, mean rain, while anti-cyclones, or centres of high pressure, will give rise to fine weather. It is clear, then, that if we can manage to tell the pressure of the atmosphere, we shall be in a position to form some idea of the weather in the immediate future.

An instrument for telling the pressure of the atmosphere is known as a barometer. If a tube, closed at one end, is filled with mercury, and tipped up, the open end downwards, into a basin of the same fluid, the height of the mercury in the tube will drop to a certain level and then remain there, the pressure of the atmosphere on the surface of the mercury in the open basin below keeping it from running out. As this atmospheric pressure varies with the various weather systems, so the height of the mercury in the tube changes. Thus the pressure can be measured by the height of the column of mercury in the tube. This is the way in which a barometer works. Thirty inches is roughly the average height of such a mercury column, but it may drop to well below twenty-nine or, in very fine weather, rise to as much as thirty-one.

Home-made Weather-glass

A simple barometer, or weather-glass, can be made from a bottle and a glass jam-jar, water being used instead of mercury. The best kind of bottle for this purpose is one that has been used for salad oil, while the jam-jar should have been made to hold two or three lb. of jam. The bottle should be placed upside down with its shoulder resting upon the neck of the jar, which should have been filled previously with sufficient water to rise above the mouth of the bottle.

Foretelling the Weather

The glass is now complete and can be made use of as a means by which the state of the weather may be foretold. It should be placed out of doors in a suitable position, and it will soon be observed that the advent of fine weather (anti-cyclonic conditions) is heralded by the water rising slightly in the neck of the upturned bottle, while the approach of wet weather (cyclonic conditions) will cause the water to sink. In making use of a glass of this kind the original level under normal conditions must be noted, so that loss of water from evaporation can be made good.

BEECHEN PILLARS OF NATURE'S CATHEDRALS

IN the second of the chapters that are being devoted in this work to the British silva we make the acquaintance of the beech—the well-known and widely-distributed tree whose smooth bark exercises so irresistible an attraction on those who would commemorate their visit to the woodland by initials rudely carved on beechen boles

EASILY recognizable at any time of the year, and widely-spread throughout the whole of the British Isles, the beech is one of our most popular and also one of our most beautiful trees. For the clean, delicate green of its leaves in spring, the cool shade of the mature foliage in summer, and the glory of the copper and gold which its dying leaves afford in autumn, it is admired by all who know it, and few trees combine so much beauty with such utility. It is a valuable wood for furniture and cabinet-making, burns well, and is much used in forestry as a "nurse" for other trees planted in its immediate neighbourhood.

Few trees have such different forms as has the beech according as to whether it is grown in a thick wood or allowed to spread to its full and proper shape in the open parklands. In the forest it is a tall, straight, pillar-like tree, devoid of branches for a height of fifty feet or more, with smooth, even, greyish bark. Where it grows in the open, on the other hand, as in the New Forest in Hampshire, or at Burnham Beeches in Buckinghamshire, it is a huge, square block of a tree, with wide-spreading branches and gnarled and twisted trunk.

In winter the twigs of the beech are completely characteristic and distinctive. They are long, slender, and arranged in a sort of zigzag pattern on account of the fact that the large leaf buds are on alternate sides of the stem. Each bud is then narrow, brown, and rather spindle-shaped, and this form is adopted by a small snail which lives on the beech twigs and holds itself in such a way that it may very easily be mistaken for a bud. The leaves are folded fan-wise within their sheath, and when they open they push the top of the sheath upwards, so that it falls to the ground, a perfect little, empty cap, when the leaves expand.

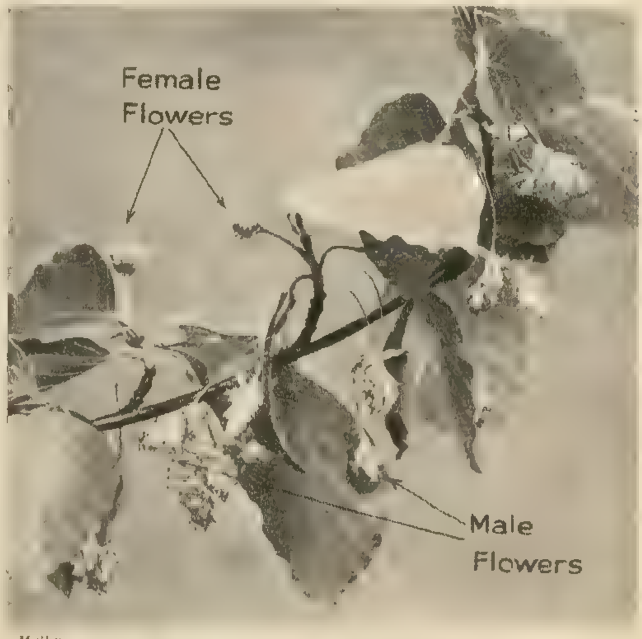
Leafy Filterers of Summer Suns

AT first these leaves, which are of a very fine emerald-green, are covered with quite long, silky hairs, but as they unfold they become darker and harder, and by midsummer they are smooth and shiny. In shape the fully-grown leaves are ovate, pointed, and have a slightly scalloped margin. They are almost transparent for some weeks, a feature which gives the shade of the beech an especially pleasant quality. Beneath the high arch of the trees all is cool, and yet the sunlight filters through so that the woodland glade is still as bright as in the open. Later the trees gleam in the hot sun of summer, reflecting the heat and making the shade even cooler and more seductive.

The flowers of the beech appear in the spring, male and female being separate. The former are produced in a catkin, from five to fifteen of them growing together; each consists of a large number of stamens, the rest of the parts of the typical flower being absent. The female flowers, which grow two, three or four together, have each three styles, and they are protected by a mass of tiny, overlapping scales. The fruit is a hard, bristly, rounded box, which splits, when ripe, into four, displaying the nuts, each of them three-cornered, within the silk-lined chamber. These nuts, known collectively as "beech-mast," were formerly the principal food on which pigs were fed in rural districts. They have long since been supplanted by more modern foods, but are still one of the staple diets of the squirrels, mice, and other animals of the woodlands. In winter they provide food for many birds, notably the brambling, a winter visitor of the finch tribe that may be most readily observed during a visit to the beech woods in the cold season. During very cold periods the ornithologist may find large flocks of bramblings and other finches feeding and grubbing among the leaf-mould beneath the beeches.

Surface Features of Beech Bark

THE bole of the beech is usually rather smooth, the bark being grey in colour, and on the larger trees there are roughnesses and splits that run up and down the bark. Often, too, the tissues near the outside of the tree develop into curious growths, and a big trunk may have hard, rounded knobs of wood jutting out from it. These may easily be knocked off, when the details of their twisted and irregular structure can be examined.



Maltby

BEECH INFLORESCENCE

The manner in which the male and female flowers grow on the stems may be clearly understood from this photograph. The female flowers grow on short, stiff stalks, while the stems which support the bunches of male flowers are long and drooping. This arrangement reduces the chances of self-fertilization, for the pollen is less likely to fall straight down on to the female flowers.

BURNHAM BEECHES

The trees at Burnham Beeches, in Buckinghamshire, are famous for their splendour and beauty in spring, summer and autumn alike. Many of the vast trunks, gnarled and scarred with age, show well that a tree carries its heart, so to speak, round the outside, for they are hale but hollow. Every bole is covered with lumps that would do credit to the hide of some prehistoric monster.

When grown under forest conditions, as has been indicated, the beech sends up tall, straight trunks, so that the wood looks like some vast natural cathedral; the first branches appear many feet above the ground, and then arch inwards to form a high vaulted roof lined with the mosaic of the leaves.

In parklands or open country, or on the banks of lanes, situations in which it often grows to a great size, the beech shows itself to be a vastly different type of tree. The trunk often splits, a few feet above the ground, into a series of secondary trunks, each of them large enough to do justice to any normal tree. These run out in all directions some sideways others straight up, so that the tree finally covers a truly enormous area. The famous Knowle Beach is said to have covered an area some three hundred and fifty feet in diameter, and there is a record of a tree at Norbury Park, in Surrey, that was 160 feet high. A girth of twenty feet is certainly not at all uncommon, and the height may often run to a hundred feet or more.

The beech is found at its best on limestone soils, especially if they are fairly fresh, and it thrives well on rich humus. This the beech need hardly ever be without, for its leaves carpet the ground so richly in the autumn that there is a constant supply of fine leaf mould beneath every tree, except on a steep slope where the soil is being continually washed away. Moreover, there are scarcely any plants that can grow beneath the beech, and consequently there is no other root system to absorb the good things of the surrounding soil. The tree prefers hilly to flat districts, and will thrive in soils that are far too poor for such forest trees as the oaks. In fact, as Evelyn observed, where oak and beech start life together, the beech will starve the oak out of existence in a few years.

Although not much planted as a forest tree, it is of use as a " nurse " to other trees, being planted to protect slower-growing species of broad-leaved trees during their youth. The fine growth of leaves produces a very good humus, as has already been remarked, and the shade and " drip " of the trees combine to keep all other plants away from the roots. Consequently, when a beech wood is cut down, we have a soil very well prepared for the reception of other trees. Another point is that a heavy shade prevents over evaporation of moisture from the soil during the summer.

The wood of the beech is very close-grained, for the tree grows slowly, and it is normally white in colour. On rich soils, however, where the growth is quicker and the graining not so fine, the wood is reddish in colour. The whiter wood is preferred by the cabinet-maker, who

uses beech for inlay as well as for the making of whole furniture. High Wycombe in Buckinghamshire is the headquarters of the important beechwood chair industry in this country. The chairs, most of them plain and for ordinary household and domestic use, were formerly made with the simple foot lathe by turners who lived and worked actually in the beech woods, their ancient craft surviving for many years from the days before machinery into the era of the modern mechanized turning-plant.

HARD and durable, these were amongst the most typical of all English articles of furniture, for the wood was as British as the men who made the chairs, a point that applies to few of the fine pieces of furniture of any age. Not only chairs but heavier articles are still made of beech, and the wood is extremely suitable for household goods such as bowls and basins and the handles of domestic utensils generally.

The copper beech, a tree which is even more beautiful and ornamental than the common variety, was apparently first discovered as a purple-leaved variety in Germany, early in the nineteenth century. Since that time it has been bred extensively all over Europe as a parkland tree, its fine colour and shape making it a valued addition to any garden. The form of flowers and trunk is not in any way different from that already described, and the sole feature of the tree is the bronze foliage from which its name is derived.

Fewer insects have their homes in the beech than in most of our forest trees, a circumstance probably due to the fact that the bark is smooth and offers little protection, while the leaves are tough and, in the big woods, at any rate, grow very far above the ground. One of the most interesting of all our moths, however, is practically confined to the beech. This is the lobster moth, a rather scarce insect which is found in the southern half of England. The caterpillar has two tails and the rear part of the body is flattened and often held up in the air in a threatening manner.

SHIMMERING SUNSHADES

The shade of the beech wood has its own peculiar quality, ascribable to the fact that the leaves are spread in a horizontal plane, so that they form a gradual filter for the light and heat of the sun. In effect, the leaves grow in such a way as to form a mosaic of foliage, constituting a sunshade as beautiful as it is efficient.

Bastin

BOLE OF THE FOREST BEECH

When it grows in a wood, or in fairly sheltered open country, the beech has an even, columnar trunk, and the bole or lower portion is straight. Here we see the way in which the bark is roughened and occasionally furrowed vertically, while there are large numbers of small splits running round the trunk. The roots run out fairly close to the surface of the ground, spreading in sturdy growth from the base of the tree in all directions.

FAST-RIPENING MAST

The nuts of the beech trees—" beech mast," as they are styled—form the principal winter diet of mice, squirrels, and certain birds. The hard cases split open in the autumn, while the leaves are still unfallen, and the nuts then drop to the ground. Besides leaves and nuts, we can see in this photograph the resting buds that will give a new crop of leaves in the next spring.

Amongst the other insects that live in or on the beech, one of the most interesting is a beetle known only by its scientific name of *Sinodendron*. Living in the stumps, or in the insides of ancient and hollow beech trees, it is cylindrical in shape, and bears on the forepart of its body a single little horn, so that it looks rather like a miniature rhinoceros. In colour this insect is completely black, and although its appearance is shiny, it is actually covered with hundreds of minute punctures, while the elytra are also deeply furrowed.

In those beech trees in which the main trunk is divided into several minor trunks, the division often takes place at such a narrow angle that there is a hollow left which, during the winter months at least, is always full of water. This acts as a receptacle for many objects and also for insects that fall in and are unable to escape. In old trees, too, there may be holes where nuthatches and tree-creepers build, and a bird that is especially fond of the great arched vault of the beech wood is the wood warbler. The bracken that grows round the edges of the wood and about the borders of the area covered by trees, provides a nesting site for these birds as well as for chiffchaffs and willow warblers. In general, however, the beech wood is a silent place, with only the twittering of an occasional insect-hunting bird and the dropping of a twig to disturb the stillness.

Ward

HAUNTER OF THE BEECH

One of the scarcer moths, the lobster moth is practically confined to beech woods. Its caterpillars seek to protect themselves, not so much by a resemblance to any part of the tree, but by startling their enemies. When interrupted they raise the fore part of the body, and their full-face aspect discourages any inquiring insect or marauding bird.

HOW TO TELL A TREE'S AGE

One of the first questions that springs to mind on observing some monarch of the forest is: How old is it? There is no definite way of finding the age of a tree until it is cut down, but we know from experience the average age of most of our trees, the age at which they are in their prime, and when they begin to decay. Once the tree is felled, however, we have a sure and exact guide as to its age in the concentric rings that are so noticeable a feature of the surface of the stump, for all we have to do is to count the number of the rings, adding one for the year in which the tree was cut down. As one ring is formed in each year of life, the result is the tree's age.

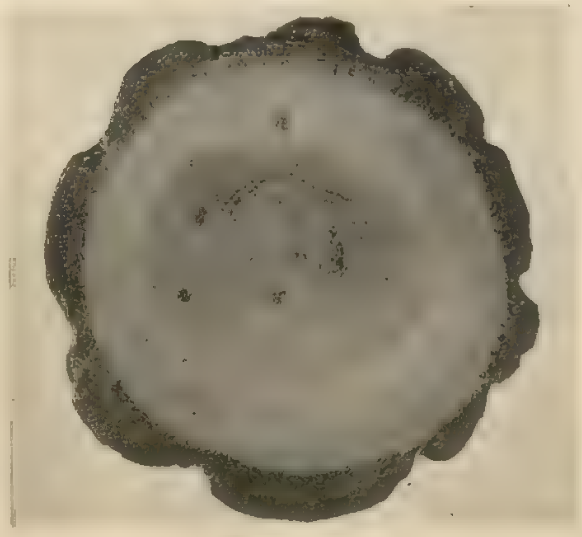
Studying the Rings

We can learn a good deal more about the life history of the tree from a study of these rings. One of the first things to notice is that the space between each dark ring, which represents the winter wood, varies to a wide extent. The innermost ring is hardly ever in the exact centre of the trunk, and very often it is markedly to one side. This shows us, then, that the growth has been very much greater on one side of the tree than on the other.

The explanation of these variations may be in the situation of the tree. Is it on the edge of a large wood? Then the growth, we will probably find, has been on the outer side, where the branches had more light and air than those on the inner side, which had to compete with the branches of other trees. Perhaps the tree grew in such a situation that one side was exposed to strong winds and the full force of the weather, while the other was sheltered from the elements; in this case we shall expect to find the rings closer together on the side that faced the storms. At the same time, however, it does not mean that the timber on that side is necessarily worse than that on the more favoured side; as a matter of fact, it may be much better, for, being grown under harder conditions and therefore closer grained, it is often of more value to the timber merchant.

Seasonal Markings

Each individual ring may also tell us a story; for the small, narrow ring is the outcome of a hard year, when the weather has been bad and has made growth difficult, while an exceptionally wide ring shows a fine year, when conditions were most suitable to the tree's growth. An accident such as the loss of a large branch may set back the growth of the tree for several years, for then there are fewer leaves to supply just as large a trunk.



The two accompanying photographs show sections through trunks of (upper left) the larch, a coniferous tree, and the oak, a deciduous or broad-leaved tree. In each case the annual rings may be discerned, showing the way in which a complete ring of wood is added every year. This wood is added between the bark and the ring of the previous year, as explained in Chapter I of Our Trees and Their Story (page 21). In the case of the oak, the transverse rays running outwards from the centre of the tree are easily seen; their absence is a characteristic feature of the conifers. The dark ring in each case shows the autumn wood, the light ring the spring wood. In the larch the section has also cut through a branch of some years' growth.

FIRST FACTS ABOUT THE SPIDER FAMILY

BELOW appears the opening chapter of a series which deals not only with spiders but with other many-legged creatures—centipedes and millipedes, wood lice, mites, and so on. Pride of place in the series is given to the spider—which, as is made clear at the outset, is not an insect as so many people confidently suppose

SPIDERS are not insects. They happen to be members of the same phylum as insects, namely the Arthropods, or jointed-footed animals, but crabs and lobsters are also members of this phylum, so that the relation between them can hardly be said to be very close. Unlike insects, which are six-legged, spiders have eight legs, and instead of having a head, thorax and stomach, their bodies are divided into only two parts, the head and the chest being fused, as it were, into one. Works of reference describe spiders as a well-defined order (Araneidae) of the class Arachnida. Spiders, then, are not insects but arachnids.

Arachnida include not only spiders, but scorpions (not found in the British Isles), mites, harvesters, and several other less common types. This class of animals is an extremely large one, and, whether found in the British Isles or in the very centre of an African forest, spiders all look much the same, varying from one another only in size and slight details of colour and form. Such a uniformity of structure is of extremely rare occurrence in the world of Nature, for in nearly all other varieties of animal forms great differences are observed between specimens from widely different habitats, and especially between those found in temperate and those found in tropical climes.

Habitats in Every Clime

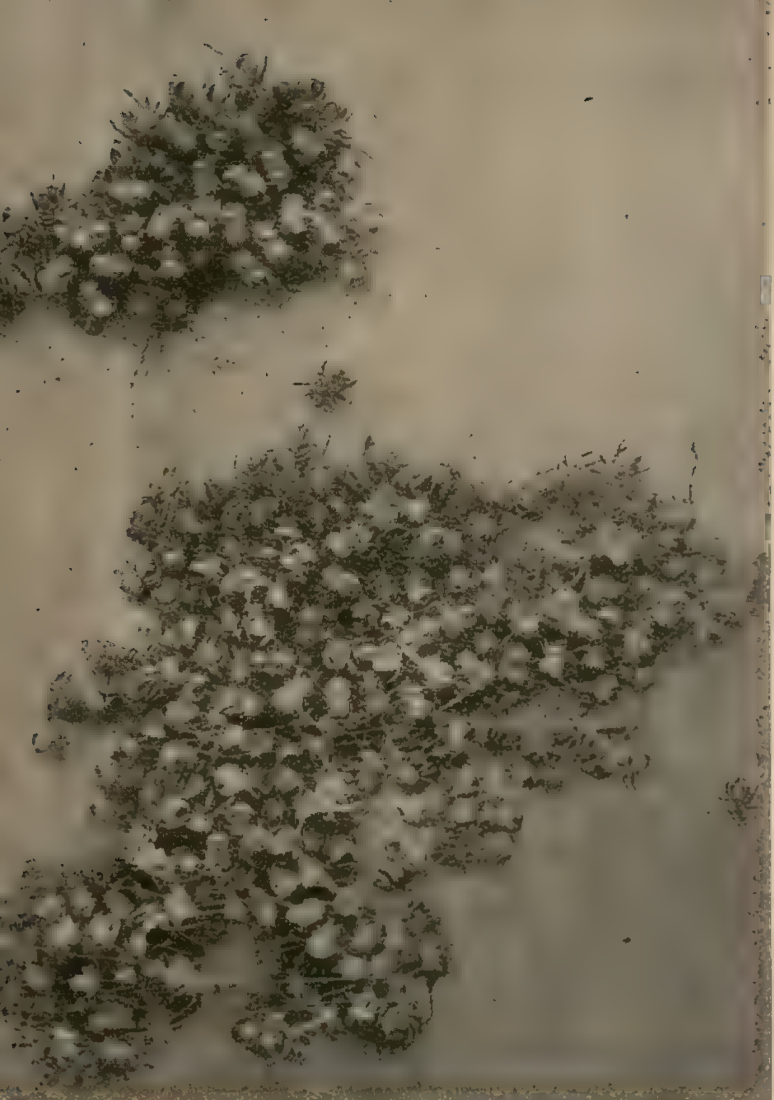
BUT even more interesting still is the fact that spiders are almost truly ubiquitous in their distribution. Wherever one may go, into the very centre of a great city, or through the dense undergrowth of a tropical forest, or to the top of a high mountain, there will always be spiders to be seen in so many different types of hiding places that it is almost impossible to lay down any single one as typical.

Naturalists when classifying and identifying any species of spider which they have not seen before make use of the fact that the lengths of a spider's legs are not always the same, or even in the same proportions. In one species the first pair may be shorter than the rest, the second pair the longest, the third the next shortest, and the fourth pair between the first and the second pairs in length. In books on spiders a formula is often made use of in describing the leg-lengths of various species. Four numbers are given, 1, 2, 3, 4, each representing a pair of legs, counting from the head back towards the posterior end of the body. The number given first shows the pair of legs which are the longest, the second number the second longest, and so on. Thus the formula, 4, 2, 1, 3, means that a particular species of spider has its hind legs longer than any of the others, its second pair second longest, its first pair third, and its third pair the shortest.

Although the physiology of spiders is much the same the whole world over, their behaviour if disturbed depends very much upon the species. Some spiders will run away at once and seek a hiding place which is often extremely hard for the inexperienced spider hunter to discover. Others will immediately roll themselves up into a sort of ball, and assume an appearance which makes the unwary investigator think that by some unobserved movement or rough gesture he has inflicted a fatal injury. These last trust to a great extent in their protective colouring, which often makes them almost impossible to see, unless they give themselves away by movement of some kind.

FRESHLY-KILLED MEAT

This house spider has just caught an unhappy bluebottle. While the four front legs hold the fly in a firm grip and the hind pairs keep the hunter steady, the deadly fangs of his mouth-parts bite into the chitinous covering of his victim. The white line indicates the spider's approximate body length



Ward

BIRTH OF A BATTALION

Here a whole horde of baby garden spiders are seen freeing themselves from the encasing shrouds of the egg-cocoon. As soon as they have made their appearance they are taken in charge by the mother spider, who looks after them with tender care—even, in some species, going so far as to carry them about with her on her back when she decides on a change of habitat.

British spiders have six or eight eyes; in other countries there are two-eyed species. These eight or six eyes are arranged on the head in a curious manner, so that the spider would be able to see in every direction with a perfect circle of vision were it not for the fact that the eyes themselves are not very efficient. The eyes are also of different sizes, varying from very large ones to others that are microscopic in dimensions. In some spiders the eyes sparkle as if set with innumerable diamonds, while in one species they are covered with a dull yellow tint, which suggests almost that the spider is blind. The spider's power of vision is undoubtedly extremely limited; there is hardly a single species which can see more than a few inches, while the majority of them are unable to observe anything farther away than an inch unless the object moves violently or is very brightly illuminated.

Maternal Devotion of Mother Spider

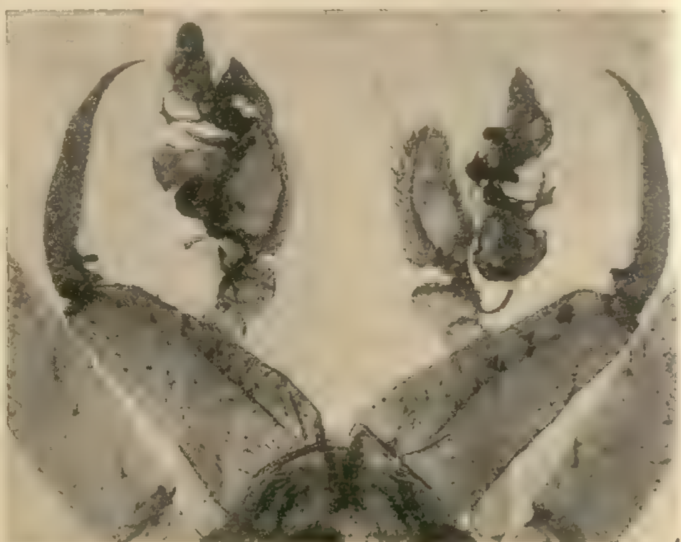
While in many species of animals the female lays the eggs and then leaves them to the care of the fates, the mother spider has very highly developed maternal instincts and sits patiently by the nest waiting for the eggs to hatch out and the young ones to appear. The mother wolf-spider, in particular, even carries the egg-bag about with her, never once setting it down until the process of hatching has taken place. When this happens at long last, she sets off once more on her travels, and all her children, numbering sometimes more than a hundred, climb on to her back and are taken with her until, in her opinion, they are large enough to look after themselves.

It may sometimes happen that a mother spider, with her children on her back, finds an egg-bag of another spider of the same species which, through one of the many tragedies of Nature, has been mislaid or in some other way lost by its original owner. The mother, already fully laden with her own children, takes the new burden under her care and sees that the tiny inhabitants get the same treatment that she has been able to give her own brood. Thus it comes about that a mother spider saddles herself with two families, and the weight of all the tiny spiders on her back may be so great that she is able to move about only with difficulty.

Poison in the Spider's Bite

All spiders are poisonous, but only in very few of them is the bite venomous enough to cause any real pain or inconvenience to Man. The head region of the spider bears two pairs of mouth-parts, one of which is the poisonous pair of jaws, or *chelicerae*, and the other a pair of six-jointed *pedipalps*. In some regions of the world bird-catching spiders can be found which will kill a bird in a few minutes with one bite from their strong chelicerae, but there are no spiders in England that can harm anything larger than an insect or a baby mouse.

In the male spiders, which are always much smaller than the females, the pedipalp is very complicated in structure and is made use of as a reservoir for spermatozoa at the mating season and as a means of transferring these into the female during the act of union. In the main, however, these pedipalps are touching organs, and in these the tactile sensitiveness which is carried to perfection in spiders generally is found in its highest development.



Ward

SPIDER ARMAMENT

The mouth-parts of the male spider are shown here enlarged by 40 diameters. Note at the sides the poison fangs, and in the centre the extremely complicated mouth palps which are made use of as feelers and as seminal reservoirs.

Stanley Crook

READY IN HIS PARLOUR

In a few short hours the spider we see here has been able to weave a beautiful web stretched between the branches of a hillside gorse bush, and is now, still as death but watchfully alert, lying in wait in the centre for the twitching of the silken threads which will tell of a victim caught in the carefully-laid trap.

At the end of the abdomen there are from four to six minute appendages which have been transformed by Nature into the spinnerets from which the silken threads, well known as a feature of the spider world, emerge hundreds of feet in length. Each spinneret resembles the perforated rose of a watering-can, for it bears numerous minute tubes (spinning-spools) through which the silk issues. On a single spider there may be hundreds of these spools, each of which is connected with a gland producing the liquid from which the thread is made. This gland is enclosed in a muscular envelope which, on contracting, acts like a syringe and forces the liquid silk down a duct and out at the opening of a spinning-spool. There are in some cases three kinds of glands, which produce different kinds of silk, and it rests with the spider to use more or fewer at one time and so vary the thickness of the threads.

Spider Spinners of Silken Webs

As soon as the thread, thus formed from a fusion of many thinner strands, comes into contact with the air, it solidifies and makes a strong rope, which will easily hold the weight of the spider which has produced it. When a spider is in danger of losing its foothold, it pays out a drag-line of silk; this is the origin of the snares and beautiful webs which spiders make use of for catching their prey and protecting themselves and their young.

The spider as an animal affords an extraordinary example of highly evolved instincts, which rival those of the insects in their elaborateness. With its very limited powers of sight and hearing, and only the acute sense of feeling with which the spider is endowed, it is hard to understand how these tiny creatures are able to construct their complicated webs and in some cases underground traps for other animals. Certain web-spiders build their wonderful snares without ever being taught, while many species see to it that at least two new nets are constructed, one in the morning and one at night, every day of their lives.

Finally, a word or two on the respiration of spiders. This is carried out by means of "lung-books," so called from their book-like appearance when opened up to expose each of the "leaves" to the atmosphere so that the blood-vessels may absorb the oxygen. Many spiders have also the *tracheae* which are such a typical feature of the insect world, but only two or three at the very most. Through an external slit situated flush with the skin air can enter the compartments of the lung-book and thus come into intimate contact with the blood which circulates through the leaves. The book is then closed and the air forced out, until the leaves come apart once more and a fresh volume of air is sucked in and the process repeated.

HAPPY SONGSTERS OF THE HEDGEROWS

A COUNTRYSIDE lacking the song of birds would seem strange indeed, for even the most unmusical cannot fail to be delighted by the exultant notes of the avian choir. In the chapter that follows we are told something of three of our best-known songsters—the blackbird, the thrush, and the thrush's near relative, the missel thrush

THOUGH they are amongst the commonest of our birds, the blackbird and its near relative, the song thrush, are also two of our finest songsters, and through their fondness for the haunts of Man are as well known on the outskirts of towns as in the depths of the country. Almost as common, though by no means so well known, is the missel thrush, a member of the same family and a bird similar in many of its habits. All three are typical examples of the great group of the passerine or perching birds.

To the casual observer the two thrushes are scarcely distinguishable in appearance. Both of them are medium-sized birds, of a general brown colour, more or less liberally spotted with black; both of them may often be seen on the lawn or in the fields, progressing in long, straight hops, and feeding on worms, grubs and insects of all sorts. The song thrush, or mavis, with which we will deal first, is a homely bird, fond of human habitations, but equally happy wherever there are thick cover and bushes. The plumage is brownish, with light tips to the feathers on the wing coverts. Beneath, it is whitish, toning on the sides into a tawny brown, and with black or very dark brown spots on the breast, some of them combining to form a streak downwards from the beak.

DEATH TO THE SNAIL

Snails are a favourite item in the thrush's menu, and this thrush has a large pile of broken and empty snail-shells collected round the base of its stone anvil. Hammered to bits, they have been forced to yield their living contents to satisfy the hunger of one of the gardener's best friends.

Crawford

The thrush nests early, and there is scarcely any time except August when it is not singing. One of the most remarkable features of its song is that the listener can never be quite sure what is coming next, for the bird will imitate other birds in such a way as at times to mislead even an expert in bird song. There have been many attempts to put into words the phrases which the bird constantly repeats; one of them may well be rendered "Did 'e do it? Did 'e do it?" and it is this phrase, invariably introduced sooner or later, that alone reveals the bird's identity. The song, which consists of a repetition of a few phrases, not in any way remarkable for their musical quality, varies greatly, but a thrush may occasionally sing notes of which not even a nightingale need be ashamed. It is for its persistence that the song thrush is best remembered; winter or summer, it sings throughout the day and frequently at night, being one of the first birds to be heard in the great dawn chorus during the nesting season; in late summer, too, the young male birds may be heard practising, their somewhat raucous notes marking them off from their more expert and considerably sweeter-toned elders.

Usually the thrush builds rather low down, choosing any situation that gives a fair amount of shelter; trees, bushes, hedges, sheds, even holes in old walls are likely sites, and there are even records of nests having been built on the ground. The basic material of the nest is grass, mixed with leaves, moss and odd scraps of wool, rags, or even paper. These materials form the walls for a wonderfully made cup of mud, mixed with cow-dung, grass or wood-chips, which, when dry, forms a most solid, and, it would be imagined, safe receptacle for the eggs. So strongly is it built that the cup remains long after the rest of the nest has rotted away, making the old nests a familiar feature of the bare hedges during winter. The cup is most beautifully rounded, fitting the sitting bird exactly and being made probably by the bird turning round and round while the plastic material entering into its composition is still wet.

Coloration of Song Thrush Eggs

THE nest is begun usually in March, and may be built within twenty-four hours, but the period from the starting of the nest to the laying of the first egg is usually at least a week. The eggs, four or five in number, are of a clear, brilliant blue, with a number of very black spots, chiefly found round the larger end; the spots may, very rarely, be entirely absent, and on other occasions are much larger than usual, when they are often browner in colour. The thrush is a very close sitter, flattening herself over the

eggs and drawing her head back at the approach of an enemy; then she suddenly rises, and with a scream disappears in the bushes. She may, however, slip silently away, and then only the warmth of the eggs betrays the fact that a bird was recently on the nest. Three broods are often reared in a single season, and the fledged youngsters, following their mothers with hoarse cries, may be seen among the fruit bushes in early summer. The young birds, in particular, do damage if there is bush-fruit in a garden, but it should be remembered that they will more than compensate for this destruction by eating insects, and, above all, snails, later in the year. It is as an eater of snails that the thrush distinguishes itself from all other birds in the garden. One may often notice, on a stone path or round the base of a stone lying on a road or by a field-gate, the scattered and broken remains of the shells of the big garden snail. These have suffered the last penalty on the thrush's anvil; the bird, having found a snail, seizes it by the edge of its shell and flies with it to its nearest anvil, where it proceeds to batter it on the stone until the shell is broken, when the luscious morsel can be extracted and eaten.

Feeders on the Mistletoe Fruit

A LARGER bird, and one that is at the same time both coarser and more handsome, the missel or mistle thrush, as it is variously called, has well earned its popular name of "stormcock." Anyone who has seen the fine cock bird, perched high on the top of some swaying elm bough in the midst of a March gale, singing into the wind with his own especial boldness, cannot fail to appreciate the aptness of the nickname. The name mistle thrush appears to be derived from the mistletoe, on which the bird is very fond of feeding, but it has been generally corrupted to missel. Greyer in colour than its better-known cousin, it is further distinguished by the clearer, rounder and larger spots which spread all over its buff-coloured underparts. The undersides of the wings are whitish, a feature which serves to identify the bird when in flight. It is more a bird of the open, and is as much at home on the bleak hillside as on the lush lawns of some well-sheltered garden. A more erect bird when on the ground, it moves with long hops, almost bounds, and runs less than the song thrush; a great digger after worms, it listens for their movements, head on one side, for a moment or two, and then starts to excavate at an amazing speed, while the turf and earth fly wide from its powerful beak. One last jab, and a long, strong pull, and the missel flies away, with powerful, direct flight, six inches of wriggling worm dangling from its beak.

About the Missel Thrush's Nest

OFTEN built very early in the year, the nest of the missel thrush is larger than the song thrush's, though built of much the same materials, welded together with mud. It is, however, lined with grass or fine roots, and the interior is more saucer- than cup-shaped. Most frequently it is placed in the fork of a tree, and though it may be completed long before the leaves are out, and may be quite large, it is often very difficult to see, harmonizing completely with the lichen-covered bark. In districts where no suitable tree may be available, a quarry, wall or crack in a cliff may be used. The eggs are dull greenish or brownish white, with brown, grey or purplish spots, irregular in outline, and scattered equally all over the surface.

GLIMPSE OF A THRUSH MENAGE

Here we see the female song thrush at the nest. While the youthful members of her hungry family cry for a meal, she appears to be intently listening, perhaps to her husband's voice from a nearby branch. The leafless boughs show us that this is an early nest, and its tangled state suggests that the bird is by no means a tidy housewife.

The food of the missel thrush is much the same as that of its cousin, comprising mostly berries in the autumn. From the summer onwards the birds go about in family parties; a small flock of them, noticeable for their wide, spreading tails held open in flight and for their occasional chattering cry, is often seen on an autumn walk, and the missel thrush is, in fact, one of the most typical birds of that season.

The missel thrush's song, though harsh, gives us great joy in the country from the fact that it is often heard in weather that would send any other bird cowering under the hedgerows, or at most hopping dismally among the bushes. Driving snow, the thickest fog or an Atlantic gale all come alike to the stormcock, whose whole character is, in fact, summed up in his voice. This has been compared by many observers to a slipshod edition of that of the blackbird; there is no attempt to make the

song musical, but it is rather a series of notes of triumph, flung out in defiance of the wind and in expression of the singer's purely physical joy in being alive.

While the song thrush's notes are those of the quiet, homely father, singing because he likes it, singing in sheer contented happiness, and the missel's are those of the boisterous man in the prime of life, shouting for sheer joy in his own strength, the blackbird is the musician of the family. Handsome, conceited, gifted with a glorious tenor voice, he is at his best in the calm of a clear spring evening, in the hush before the final chorus, as if he knows that all the world has stopped for his solo. Frighten him, put him off his note, and he gives a shrill and rattling scream, even louder than that of his wife, and flies shouting through the bushes.

Blackbird Dandy and Dowdy

CERTAINLY, the cock blackbird has a right to be self-satisfied, not only about his voice but also about his appearance. No other bird can lay claim to so beautifully tailored an appearance, to so glossy a black suit or such a brilliant orange bill, and his fine carriage only goes to enhance his sartorial perfection. The hen bird, on the other hand, almost merits the description of the " dowdy " of the thrush family. She is brown, darker than the thrushes, but with much the same general scheme of plumage; the breast and lower breast alone are light in colour, shading from the throat backwards to deep brown; the throat is streaked and spotted with blackish colouring. The female blackbird will probably often be mistaken by the beginner for a thrush, but her general darkness should serve to distinguish her. The young birds of both sexes often have the same general coloration; the adults are very slightly larger than those of the song thrush.

Fletcher

BLACKBIRDS TO BE

The deep cup of this blackbird's nest has a floor of mud, with a lining of grasses and rootlets. The generous mottling of the eggs is easily seen, and the way in which the nest is hidden deep in the bush, far from prying eyes and hands, is equally evident.

HOUSEWIFELY PRIDE

The fine, upstanding carriage of the missel thrush is well displayed in this close-up photograph, and so, too, is the neat structure of its nest, placed not in a bush like the nests of song thrush and blackbird, but on a tree some distance above the ground.

Vickers

The blackbird's nest is found in much the same situations as that of the song thrush, though it is more frequently confined to thick bushes, undergrowth and low trees; the materials are the same, but the lining is of grass over a rougher cup of mud. The four to six eggs are laid in March; they are greenish-blue in colour, thickly speckled at the larger end with reddish-brown. Some eggs are more thickly spotted, and very occasionally there are very marked spots of the same colour. There are two or three broods. It is quite in character that the cock bird does little, if any, work at the nest, although he does condescend to help his wife in feeding the young before they are able to fend for themselves.

Fights for Feminine Favours

DULL though she is, the hen bird is often the cause of fierce battles between rival cocks, and after the contest the victor may have to pursue the hen, along the ground and in the air, before his conquest is really complete. Although as many as half a dozen cocks may join in the struggle for a single hen, they are generally careful to avoid serious damage. The more domestic fights between rival hens are frequently fiercer, but the birds of both sexes are temperamental and very quarrelsome. To the observer, walking through a thick wood, there is nothing more irritating than the wild scream and rattle of a startled blackbird, which frightens in turn every other bird within hearing and ruins the hopes of making any useful observations. The blackbirds might well be termed the alarmists of the woods. When frightened, they fly rapidly and noisily for some distance, and on alighting, on branch, hedge-top or on the ground,

voice. The song has wonderful variety, and on a still evening may be heard over half a mile, but there is a weak and sudden finish, often ending in a mere subdued hiss. The bird sings over a limited period, chiefly from February to July, although it may be heard in midwinter in mild years. In the autumn the young cocks may sometimes be heard trying their voices.

Three other closely related thrushes are found in the British Isles, the ring ouzel, the fieldfare, and the redwing, which, although not true residents, are among our most regular migrants. The ring ouzel, a bird of the moorland and the mountain, nests in the north of England; the fieldfare and redwing are winter visitors from Scandinavia. All three birds will be fully described in a later chapter.

Teager

TENOR OF THE GARDEN

Sitting on an apple bough, the cock blackbird displays to all his fine, neat figure, and at the same time gives us a concert of real beauty. Later in the season he will raid the same apple tree for its fruit, and will suffer a severe diminution in popularity in consequence of his successful forays.

WHO GOES FIRST?

Fledged and ready for their first flight, the young blackbirds are rather doubtful of their newly-won powers, and each seems to be anxious that another should take the first plunge.

Newman

sit and raise and lower their tails, the feathers spread wide, as if in an effort to calm their shattered nerves. On the ground, too, they run more than do the thrushes, and jerk the wings and tail as if in a continual state of nervous tension.

Peckers of Forbidden Fruit

BLACKBIRDS are amongst the greediest of all our birds, and there is no doubt that the damage done by them to bush-fruit is considerable; later in the year they will peck at apples apparently with no intention of finishing their meal, and will then start afresh on another tree. Their passion for fruit, ripe or unripe, only too often leads to their undoing, either in the netting or from the gardener's gun.

Much has been written about the blackbird's song, considered by many perhaps the finest of any of our birds'. It is a whistle of great purity, with only an occasional harsh note, and the bird is a passable mimic, not only of the notes of other birds but of the human

MORE HINTS ON BIRD-WATCHING

The systematic bird-watcher will find himself amply rewarded for his trouble by the new knowledge gained of bird habits and characteristics, but, in addition, he will probably find that, as a result of his increased powers of observation, he is able to discover the nest. When two birds, which from their behaviour have shown themselves to be a pair, are observed to be collecting such materials as grasses, fine twigs, hair, feathers, or even, as is possible with many of the larger birds, rags or paper, we must redouble our efforts to find out exactly where these objects are being taken. If the birds have been traced as far as a hedge, it will be worth while to spend some time watching at the place where they disappear, so as to ascertain, if possible, whether their nesting site is in the hedge or whether they fly on and over it. In the latter case, we may have to track them for some distance before we can find the site.

Notes on Nests

It is as well to remember, however, that no bird will go farther than it need to collect nesting materials or food, and usually the birds we see at work in the garden are building fairly close at hand. Notes should be made of the materials used in building the nest, even before we have found it, and when an opportunity to study its construction comes, we can see the different way in which each article is used.

Much amusement can be obtained by providing, during the nesting season, suitable materials for some of our more common birds. Feathers provide one with an obvious opportunity, and they will give the birds a chance to demonstrate to us their powers of flight. On a breezy spring day, if we are lucky enough to have swallows or martins nesting near at hand, we may throw up some feathers into the wind and watch the birds as they hawk after them, stooping and diving to pick up the finest and most delicate pieces of down, prized for lining the nest.

In the rickyard of a farm we may watch sparrows and other birds carrying off straws, for they form one of the principal nesting materials of many birds. If we come later to examine the nests of the birds in the garden, we often find pieces of material, paper, or rags taken from the rubbish heap.

The Life of Our Seashores. 1

MARINE MARVELS AT THE WATER'S EDGE

THANKS to our excellent travel facilities, an occasional trip to the seaside is now a recognized feature of our daily lives. However long or short the visit may be, it will be made infinitely more enjoyable and beneficial if one has some knowledge of the ways of the many strange creatures to be encountered on the beach, and in this series of chapters we shall learn sufficient to add zest to the walk along the beach for all the days of a long summer holiday—and of more holidays than one

THE clean sweep of the seashore at low tide and the smell of the seaweed lying in the sun; the wrinkled sand and the lapping of the waves, or the sudden advance of the incoming tide; the sight of swirling waters from a rocky cliff top and the dull, booming sound of waves breaking within a cave; the sigh of the wind blowing over the moulded sand dunes and the roar of great breakers on shingle in a storm: these are impressions which remain in the minds of all who have wandered about that most fascinating of playgrounds, the shore.

But the true Nature-lover is not content merely to admire; he must attempt to understand, to pry with his mind into that vast variety of geological formations and animal habitats presented to him on the seashore. A short tour by car of a very few miles, or even a walk along the coast on the cliff top or on the sand beside the waves, will lead one whose eyes are opened into a realm of strange forms of life and even stranger ways of living.

The animals we see making their homes in the countryside inland are adapted for and shaped by the environment in which they find themselves. Living on land, they are supplied with legs, with a natural covering to keep them warm, and with lungs with which to breathe the air around them. The fish that we see in our ponds and streams and in the waters of the ocean, spending their lives in a completely different habitat, are therefore very different in appearance. They have no legs to walk with, but fins with which to swim. Since their blood is of the same temperature as the water about them, they do not require any covering to keep them warm, but only scales to protect their bodies from harm. They do not breathe the oxygen in air directly, as do the land animals, but make use of the dissolved oxygen to be found in water; they have, therefore, no lungs, but are supplied with gills, which bring the blood into close contact with the water.

Where Life Follows a Rhythmic Beat

SUCH alterations in appearance to suit environment are natural and to be expected in land and sea creatures. How different are things on the seashore! Here the environment varies considerably even with the time of day, owing to the rise and fall of the tide, which thus covers and uncovers a stretch of land twice in every twenty-four hours. It is clear that under these conditions the adaptations of the animals and plants living on the shore will be very different from those of either the true fishes or the true land animals. Yet, in spite of the difficult conditions under which it has to survive, it is astonishing how abundant is the life of the seashore. The nature and reason of these adaptations and evidence of an abundant and extraordinarily interesting array of fascinating little animals and plants which can be seen nowhere else, will become apparent if we take a short but observant walk along the coast.

The best time to begin our walk is at low tide, when the hard, damp sand withstands our steps and the retreating waves lap softly at our feet. Behind is the little seaside town, perhaps nothing more than a fishing village, and in front the never-ending seashore, the cliffs, the sand, the shingle banks and, on one side, always the expanse of wide, blue sea. The ebbing tide leaves a feeling of cleanliness, with a touch of that sense of a new lease of life such as we experience in the Spring. Overhead the gulls are squawking a protest against our invasion; their harsh cry is less mournful now in the sunlight than it will be at dusk, when it indeed resembles the ghostly wail of sailor-spirits, with which gulls are still identified in some of the remoter parts of Cornwall.

Along the Beach at Low Tide

AS the walker steps across the pools left by the retreating tide, he will notice thousands of little piles of wet sand covering the beach, and if he is a fisherman he will recognize them as the casts of the lug-worms. Here is an example of an animal which has almost perfectly adapted itself to the strange environment of the changeable seashore. The lug-worm, dissatisfied with the ever-changing conditions of the beach, where at one hour the sun beats down upon it and at another it is covered by the waves, has made for itself a home below the surface, and lives practically all its life a few feet under the sand, which protects it from both sea and sun.

In the pools themselves there will also be found something of interest, for here and there may be seen the shells of a great many different kinds of seashore animals whose shapes and habits have enabled them to survive in such a variable habitat. A small hole in the surface of the sand may show where a heart-urchin lies hidden in its burrow. Here it spends all the hours of low tide and eats nothing but sand, absorbing into its system the organisms found in it, and throwing out the waste when finished. Clams also lie just under the surface and can be located by their thin outlet tubes. The head of what looks like a tiny fish half buried in the sand may be observed, but, if examined more closely, it will be seen to be the mouth of something that is half free-swimming fish and half sand-living worm. It is Amphioxus, an extremely elemental fish which lies in the sand with only its hairy mouth protruding into the thin film of water above it, in which it finds nourishment and oxygen to keep it alive. Razor-shell clams, the Corystes crab,

Dixon-Scott

—AND SANDY SHORE

Along a sandy coastline, the sea winds blow the sand inshore and pile it into miniature mountain ranges of rolling dunes, which continually change their shape until the hardy marram grass makes good its hold. In this photograph taken at Gwithian, Cornwall, the marram stalks are shown heavy with well-loaded ears of seed.

ON ROCKY BEACH

Wherever gently-sloping rocks lie exposed at low tide (as on the Devon beach shown below), seaweeds of all kinds will be found. In the pools the sea-wrack is floated to the surface by air-bladders on the fronds, which can be heard popping in the heat of the sun when they lie unprotected on dry land.

a worm known as Balanoglossus and a great many other forms of animal life have found this strange corner of the earth to live in and have become adapted to an existence under these conditions.

As we pursue our way along the shore we are almost certain to come upon stretches of rocks and high cliffs, and it is here that the superabundance of life strikes the walker most. When the tide ebbs the miniature canyons and gorges in the rocks are left filled with water, and in these limited habitats other new and equally interesting animals and plants are to be found. Seaweeds grow on every possible rock and in every cranny; they make a brilliant mantle for the rocks, with the occasional green weeds relieving the predominant brown, sometimes almost black, colourings. Many of these seaweeds have pneumatic bladders attached to them, so that when the tide comes in they automatically float upwards towards the light, and are held apart from one another in such a way that they come into contact with the maximum amount of water. During the long hours of low tide and in the heat of the sun these plants of the sea look strangely out of place, and one is tempted to believe that it is only through chance that we find them in this particular habitat. This is, however, not the case,

WHEN THE TIDE IS OUT

The superabundance of sand-living marine animals is made apparent by the millions of casts thrown up to the surface of the sand at low tide. In some parts of the North Wales coast, for instance, one turn of the spade reveals swarms of lug-worms, as well as heart-urchins and razor-shell clams, and an occasional Balanoglossus and Amphioxus, which come to the surface only when the tide is in.

Cullsford

for the seaweeds found on the rocks are just as much a part of the seashore plant and animal "association" as the sand-eating worms and shellfish.

In the pools will also be seen anemones of many different colours, having the appearance of strange fungoid growths with their fat, squat bodies and waving feelers placed around their mouths. It can soon be shown, however, that these lovely organisms are not plants but sentient animals, for if the tip of the little finger be inserted into one of the mouths the waving feelers will shrink at once into the stumpy body and a distinct sucking sensation will be felt. The anemone makes use of these feelers to catch its food, which, once it is seized, is immediately sucked into the stomach.

Varied Members of the Crab Colony

Between the barnacle-encrusted rocks and under the stones are a great many different types of crabs, some of which are particularly interesting. The hermit crab, for example, does not possess a shell of its own, but makes use of the shells of other shore-living animals. The mittened crab, an invader of our shores from the seas of China and Japan, has the appearance of any ordinary "eating" crab sold in the fish-shops, but is in reality the carrier of an extremely dangerous disease. It is, however, distinguished from the true English variety by a thick growth of hairs on its legs and pincers which gives it the appearance of wearing gloves.

Should the incoming tide threaten to "cut us off," we must take to the cliff top before it is too late. There we may not only continue our walk in safety, but find new examples of Nature's wonders, particularly if the cliffs slope towards the beach and give place to sand hills, while banks of shingle border the sea.

Strange plants grow among the wind-blown dunes and on the great heaps of storm-raised shingle. Among these may be recognized that little flower, at first sight so similar to the grass growing about it, but which has light pink blossoms by which it may be easily recognized as thrift, or sea pink. On the shingle may be seen that rare plant the sea pea, and further inland sea lavender, sea holly and other plants peculiar to the shore can perchance be discovered.

Fauna of the Banks and Mud-flats

As the sand hills gradually diminish in height and eventually disappear altogether, wide mud-flats taking their place, we realize that we are approaching the mouth of a river. In the distance the wide expanse of the river estuary shines silver in the sunlight, its flat contour being broken on the other side of the water by distant mud-flats and perhaps an island or two.

Here on the sand at the mouth of the river, where the mud yields to the action of the waves, we come upon large numbers of cockles and mussels, while clams and crabs of every kind will be discovered on all sides. Here and there also will be seen starfish cast up by the waves and perhaps a sea-urchin, like some strange fruit of a far-off land carried hundreds of miles across the ocean by the winds and tides.

All the forms of life mentioned above as being customarily found on the seashore have interesting connexion with

From "The Biology of the Seashore"

TENANTS OF THE SEASHORE POOL

Through the clear water of a rocky pool, the creature of the ebbing tide, strange forms may be seen clustered together. Here a starfish (left), a sea-urchin (centre) and a crab have been forced to live for the nonce as near neighbours, together with the more indigenous barnacles and anemones on the rocks behind them.

the naturalists' theories of the evolution of animal forms. If there is one statement concerning the origin of life that is reasonably certain, it is that life must have begun in the water.

During the process of evolution there must have come a time when life left the waters of the ocean for the air and the dry land, and it is reasonable to assume that between these two stages there was a transitional stage, when many animals and plants lived half in and half out of the water. These original conditions in the history of evolution are being held, as it were, in a state of preservation on the seashore, where the animals have remained perpetually in the transitional stage.

Much scientific research has been carried out on the physiology and anatomy of seashore life, and it appears that one of the chief factors making it possible for these animals to exist at all under such strange conditions is the adaptation of the concentration of the salts in their blood to the same degree as the saltness of the surrounding water. Thus on an estuarine beach, where the water is somewhat less salt than in the sea, the concentration of the salts in the blood of any animal discovered there is much lower than the salt-concentration in a seashore animal, while in some parts of the world, such as portions of the coast of China, where the land is flooded by sea water only once in every few years, the concentration varies in a single individual often several times during its lifetime. This adaptation of such a fundamental physiological quality as the blood-concentration to the surrounding conditions shows just how sensitive and ready to cope with any change are these animals which have been left so far behind in the race of life.

A walk along the shore thus not only introduces us to many new wonders of Nature and presents to us some of the most beautiful exhibits to be found in her galleries of art, but also gives us an important and probably unexpected insight into the evolutionary process.

HOW TO COLLECT SEAWEEDS. 1

The seashore is undoubtedly the collector's paradise. Collections can be made from so many different things that the chief problem with which the enthusiastic littoral naturalist is faced is the selection of a subject. Perhaps the easiest collection, and one of the most instructive, can be made from the large number of brightly-coloured seaweeds to be discovered on the rocks at low tide.

The fronds of the weeds should be carefully cut from the rocks with a pair of scissors, and then put straight into a jam-jar of fresh sea-water. When a number of pieces of various colours, shapes and sizes have been accumulated the collector should return home with his treasures and prepare them for preservation in his pressing books.

Cleaning the Weeds

The first process is to put them into a small bath of sea-water for cleansing. Fresh water should not be used, since it causes the weeds to decompose. The next stage is to transfer them to another vessel containing sea-water that has been filtered through a piece of muslin, and any lingering impurities can be removed from the weed with a camel-hair brush.

Cartridge paper should be used for mounting, and the seaweed should be lifted from the water by means of a piece of perforated zinc with one edge turned up. The zinc, with the paper resting on it, should be put into the water underneath the specimen. The weed can thus be lifted from the water and, before being actually removed into the air, it should be arranged neatly and artistically with the brush.

The specimens can then be fixed in place with a brush dipped in fine gum and the sheets of paper filed in a book set aside for the purpose.

FOUND ON MANY A BEACH

Two of the commonest seaweeds are shown in these illustrations. Above, the dark-brown bladder- or sea-wrack of the rocks (*Fucus vesiculosus*); right, *Chondrus crispus*, the carrageen moss, which has a beautiful red coloration.

THE FARMER'S FINGER IN THE RURAL PATTERN

THE chapter that follows is the first of a series specially devised to satisfy the curiosity and enlarge the experience of the urban visitor to the countryside. Here we shall learn of the activities of the farmer and of his influence on the scenery of our land—of the composition and meaning of the agricultural landscape

THE beautiful pattern of the countryside of Britain is made up as much from the many-coloured fields of cultivated crops as from the heathered expanses of the mountains and moorlands. The common belief among townsfolk that in order to see any of the beauties of Nature one must go forth into the so-called "wild regions" is quite unjustified, and the Londoner, for instance, should not be disappointed with his visit to the country if he has seen nothing more than fields of golden wheat, or yellow mustard, or the wind-rippled grasses of a field of standing hay. The appreciation of such views, of course, requires more than just an eye for scenery, but, given a little detailed knowledge of agriculture and its difficulties, the rambler should find much food for thought in surveying the Midland and East Anglian agricultural plains.

The complex network of blackthorn hedges dividing the face of Britain into a chess-board of green, brown and golden fields is one of the most typical features of our landscape. The colonial visiting this country for the first time invariably comments upon the small size of the fields and the large number of enclosures made use of by the farmers. On the Continent, too, the hedge and the fence are rarely, if ever, employed by the peasants for the division of land, and the cattle, rounded up in the evening from the sound of their bells, range at will over the countryside. But if the sound of cattle-bells is absent from the beautiful setting of Nature in Britain, the hedges are there to compensate for the loss, and to provide a feature of landscape and a home for wild life as unique as the character of the British people themselves.

When the Town-dweller is Nonplussed

AN agricultural stretch of country may display to the rambler a large number of different types of crops which, as often as not, pass unrecognized, are misnamed, or are completely ignored. To the uninitiated wheat, oats, barley and many of the other "cereals" are all "corn," and every root crop is called "turnips." Another crop frequently unrecognized is the yellow-flowered "mustard" plant—*Brassica nigra* (from which mustard is made) or *B. alba* (grown for forage); when seen in this country as a glaring yellow patch amid the greens and browns of fields carrying less brightly coloured crops, we may suspect that the farmer has planted it there either as fodder for his cattle or merely for the purpose of fertilizing the soil.

The countryman finds it hard to believe that there is anyone who cannot distinguish between wheat and barley, yet, in fact, there are hosts of townsfolk who, travelling through the country and encountering a field of standing "corn," are unable to decide on its name. These may be interested to know that ears of wheat are much more compact and far neater than those of barley, which taper off into a number of fine, needle-like spikes, giving a hairy appearance to the crop; a wheat field has a well-groomed look which is completely lacking in a field of barley, however neatly and carefully it may have been planted. A useful thing to remember concerning these two crops is that it is not advisable to sit and rest on barley straw, as it harbours innumerable insects and spiders with the most virulent of stings. Wheat straw, on the other hand, makes an excellent and comfortable bed, and the weary rambler who is unable to find a country inn in which to spend the night may do much worse than get permission from a farmer to sleep in one of his barns filled with this kind of bedding.

"Roots" in British Farming Practice

THE technical distinctions between the various roots are more difficult to understand, and may be left to be described in the later chapters dealing in detail with these crops. In passing, however, it may be well to mention that sugar beet is much the smallest of this type of crop, and that mangel wurzels are usually the largest.

Roots were introduced into British farming practice by Viscount Townshend of Raynham, in Norfolk, about 1730. Before these crops were generally grown on farms there was no such thing as "winter food" for the cattle, nearly all of which had, therefore, to be slaughtered with the coming of winter. Townshend's success in providing his beasts with food throughout the year revolutionized not only British farming, but the habits and general methods of the British farmers themselves. Roots are sown early in the year, and the plants are set in rows about two feet apart, thus allowing for the full development of the land between them by means of hoes and ploughs. Weeds can, therefore, be kept down and the full benefit of the soil given to each individual root as it grows. Because of this the introduction of the root crop paved the way to the elimination of the old, bare "fallow field," a relic of medieval days, left vacant and wasting once in every three years.

Some of the practices carried out by farmers on the land seem obviously to be dictated by "rule of thumb," but on examination from a scientific standpoint many of them are found to be perfectly sound. Of these practices, one which the townsman generally prides himself on being able to appreciate is the rotation of crops; and it is interesting to note that in modern scientific circles this is one of the few rural methods which is looked upon with a measure of doubt. Its abandonment would certainly change the face of the countryside so far as he is concerned, but there are other

The Times

TWO HORSE POWER

On the lower slopes of the South Downs near Alfriston (seen in the background) two masterly exponents of the art of ploughing guide their horse-drawn shares through the thin soil just as have done their forefathers year after year for many a century.

TWENTY HORSE POWER

In contrast to the method pictured in the upper photograph, we have below a view of a Ford agricultural tractor developing twenty h.p. driven by an engine running on paraffin. This farm is obviously of most modern type, for ploughing has begun before harvesting is over, and the shocks have been piled on ventilating tripods at one end of the field.

RICK MASTERPIECES

Only the ignorant think of the work of the agricultural labourer as being "unskilled." On the contrary, some of the rural arts—rick-building, for instance—demand so high a degree of craftsmanship that they are practically reserved for specialists. This photo is of some ricks on a farm in Middlesex.

improvements now being introduced which will make it even more unfamiliar. Whether or no, for instance, the introduction of artificial manures will radically change the whole organization of the farm cannot yet be decided, but it is certain that the urge towards national self-sufficiency will in time make it necessary for farming to be carried out on the lines of modern industry.

A knowledge—however superficial—of the methods and technique employed by the farmer and his men, as well as of the crops they raise and the systems they use, gives a new interest to any walk through agricultural country. In the autumn months a slight acquaintance with the ploughman's art will reveal the degree of efficiency of the farm-hand expressed in the various fields which have yielded to the plough. Here a crooked furrow may show where a young ploughboy has taken the reins for the first time, and there a "badly turned" turf, with the green grass and brown stubble peeping above the furrow, tells its tale of a moment of carelessness or an over-worn share.

With the development of the internal-combustion engine, ploughing has rapidly become mechanized. On the majority of farms in Britain, a 25-h.p. tractor is employed to haul two or three ploughs simultaneously, each share cutting to a depth of from eight to twelve inches. The standard power formula for ploughing medium soil is 7 lb. per square inch of furrow cross-section. The general tendency with mechanical ploughing is to cut deeper furrows than was customary with horse-drawn ploughs. On the large, flat fields of Lincolnshire, it is common to employ a 90-h.p. tractor with caterpillar treads drawing a heavy plough which cuts furrows down to a depth of 30 inches.

Among recent improvements in mechanical ploughing is the practice of mounting the plough at the rear of the tractor so that it becomes an integral part of the power unit. This ensures the maximum penetration and the cutting of even furrows in hard ground, besides making for greater manoeuvrability and easier turning than with a tractor trailing a coupled plough.

In mechanical ploughing, the normal method is to cause the plough share to turn the soil to the right-hand. To start ploughing, a ridge is formed by driving across the field, turning round, and coming back parallel with the first cut. Several of these ridges are formed parallel to one another and furrows turned round and between them. The headland, which is left for turning, is ploughed when the main part is finished.

Revealers of Nature. 2

CHARLES DARWIN

THE man who completely transformed the whole scientific outlook of a century and on whose scheme of evolution all modern biological research is based, might well be accepted as a "revealer of Nature," even if the enunciation of a revolutionary general theory had been his only contribution to Nature-study. But Charles Darwin, far from confining his attention to the general, was a student also of the particular and of the often overlooked minutiae of Nature; where "The Origin of Species," "The Variation of Animals" and "The Descent of Man" roused world-wide controversy among theorists and caused Darwin to be condemned as anti-Christ, his minor works, although they passed comparatively unnoticed, were in a sense as valuable and almost as revolutionary. Such are "The Voyage of the Beagle," a mine of information on all matters interesting to the naturalist; "The Formation of Vegetable Mould Through the Action of Worms," a masterly and most original treatise on the earth's humblest creatures; "The Fertilisation of Orchids, and Effects of Cross and Self Fertilisation"; "The Movements and Habits of Climbing Plants"; "Different Forms of Flowers"; "The Power of Movement in Plants," and many other books and papers read before scientific societies on an almost encyclopedic range of subjects. Darwin always preferred to call himself, not a scientist or a biologist, but a naturalist, and it is rather on these minor studies that the justice of that claim rests. Like Bacon, he took "all knowledge as his province," and he threw fresh and revealing light on every subject that owned him as one of its students

The grandson of a scientific poet whose poems were among the worst produced in the 18th century but whose scientific studies foreshadowed those of his greater descendant, Charles Darwin was born at Shrewsbury on February 12, 1809 At the age of twenty-two he secured the post of naturalist aboard the survey ship *Beagle*, and seven years later he was appointed secretary to the Geological Society. Four years later, in 1842, he settled at Downe, in Kent, where he spent the remainder of his life and where he died on April 19, 1882 His whole life was devoted to science.

It is significant that, apart from visiting the Atlantic islands, Australasia, and South America on the *Beagle*, Darwin found no need to seek far afield for objects of experimentation or contemplation. For forty years the garden of Down House was his laboratory, and it was on the phenomena which he observed there, as any householder may observe them in his own garden, that his great discoveries and revelations were based. This is a sign at once of the power and of the simplicity of his mind. Let the reader go out into his own garden and watch, say, the earthworm; then let him read Darwin's book on that lowly creature, and he will realize the amazing powers of observation that he possessed

WINGED ARRIVALS IN THE SPRINGTIME

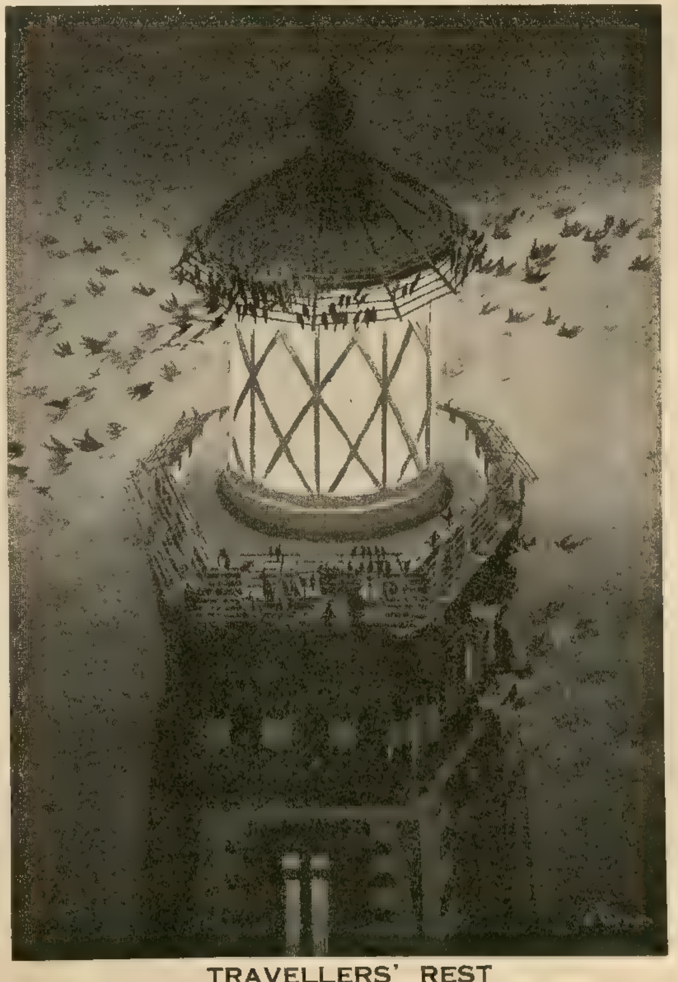
Of the many problems presented by bird life, migration is perhaps the most fascinating and most hard to solve. Every year our shores are visited by hosts of migrant birds, who find their way to and fro across thousands of miles guided by that mysterious something called instinct. In the following chapter some of the spring migrants are discussed; the autumn arrivals are dealt with in later pages

Migration—the arrival, so sure and regular that we scarcely notice it, of thousands of birds, large and small, familiar and unrecognized, songsters and silent. That is all it means to the average man or woman, who has perhaps vaguely heard of it as a term that sums up the fact that the swallows are with us in summer and gone in winter. And yet, of all the mysteries of bird life, none is so profound, and none, despite the research and the theorizing and the watching of experts and scientific ornithologists, has remained so baffling. Somehow, from somewhere, out of the blue, across the sea, down from the sky, come the migrant birds, every year from February to June, winging their way against odds that would appal any other creature, crossing seas and countries in the darkness of the night, and yet arriving, as often as not, at the very same place that they left the previous autumn, although its appearance in the garb of spring may make it scarcely recognizable when compared with the conditions of the fading year.

This is migration at its highest point, the vast seasonal migration of our visiting birds, and this is migration as it is understood by the majority of people. But in reality it is migration at one end of the scale only, for at one time or another every bird migrates. The gradation from one extreme to the other is very gentle. One bird may fly two thousand miles in the autumn, and back again in the spring; another flies only to the south of France; another merely crosses the English Channel; others, again, come from the north of Scotland to southern England, or from Norway to our eastern coasts; some species move merely from the mountain tops to the plains; some from the open moors to the cultivated country, from the fields to the woods, from the woods to the gardens. Every day the rooks fly from the roost to the fields where they feed. Even the very blackbirds and thrushes that are on our lawns in winter may not be those that sang and bred in the garden in the summer. And so it goes on, the ceaseless change of habitat, as each bird, driven by some unknown force which lends it strength that is literally superhuman, follows the conditions that suit it best.

Much has been written on the why and the wherefore of bird migration, and innumerable theories as to the instincts and impulses that govern it have been submitted by scientists of every rank and qualification, but it remains, and is likely to remain, a mystery. On the other hand, an equally large number of very definite and very impressive facts have gradually accumulated, revealing further and further the extent of the wonder, but going only a little way towards its solution. It may be as well to note some of the salient facts that have been accepted and duly recorded year after year.

Our birds have been divided, more or less rigidly, into the following classes: permanent residents, that is, those which remain the whole year and nest with us; summer visitors, birds that arrive in the spring and leave after the nesting season; winter visitors, birds that nest to the north and come to us for the winter months; passage migrants, birds that are recorded every year but never stop to nest, passing to the north in spring and to the south in winter; irregular visitors, which stray occasionally to our shores, usually storm-driven; and spasmodic immigrants, birds which appear suddenly in large numbers, probably as a result of overcrowding in their normal homes, in a vain effort to extend their range.



TRAVELLERS' REST

Every year many thousands of migrant birds reach our shores in an utterly exhausted state, often after many hours' battle with adverse winds. Tired and weather-beaten, they are attracted to the lighthouses on our southern coasts, and this picture shows the rests that have been specially built for them at St. Catherine's lighthouse, in the Isle of Wight, which is situated on one of the most frequented migratory routes.

The majority of our common birds belong to at least two of the above groups; for this reason the first of the categories can include only individual birds, since there is no species of which we can say that, in general, its members are in the same place throughout the year.

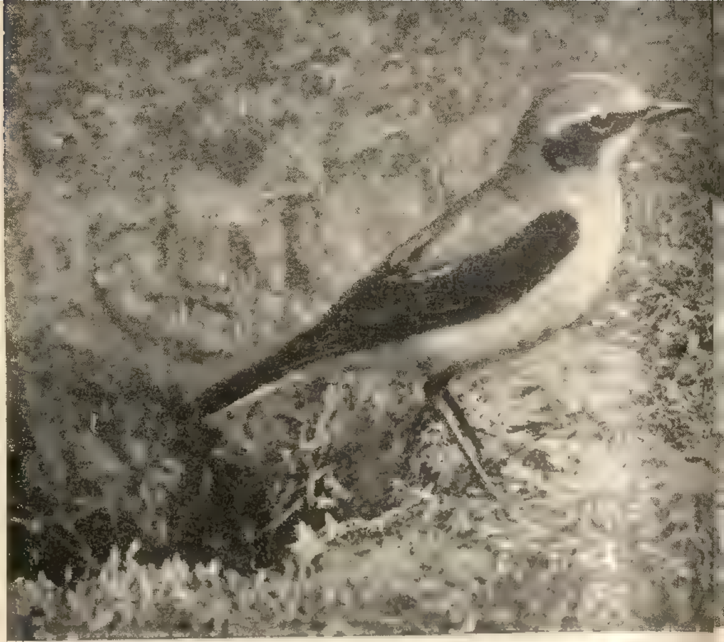
This fact is perhaps partly accounted for by Nature's rule against overcrowding; a clutch of five young thrushes obviously cannot stay for ever in the garden where they were bred, since sooner or later there will be a food shortage, especially if they themselves start to breed. With the more territorial birds and birds of prey this state of things is even more striking; robins, for instance, divide up a given piece of land very strictly into territories, each large enough to feed one family; there is no room for a new colony, and the young must go farther afield until, by luck or by conquest, they come across a place where there is space. This, of course, is true only of the summer, for the most territorial birds may become wanderers in the winter months, when they must at all costs seek food that is accessible. One bird, then, may spend its whole life in one small area, but of no species can we say that it is purely non-migratory.

Summer visitors include all those birds which are popularly associated with the idea of migration; the swallow and the martin, the swift and the cuckoo and the turtle dove all winter beyond our shores, and their arrival in the spring is the most noticeable feature of all migration. Very occasionally we find members of this group, such as the swallow and a few of the small warblers, wintering in the extreme south-west of the country, so that, if the idea of migration is limited to birds that go abroad for the winter, these are residents. Many of the birds which reach this country in the spring belong to the fourth class, for they stop only to rest for a day or so, and then continue their journey farther north; while some individuals may do this, others will remain and breed. Some of these

MODEL HUSBAND

One of the sweetest of our lesser-known songsters, the tree pipit nests on the ground, and here we see the male bird, with a truly commendable sense of duty, feeding his spouse as she sits on the nest. Snug in her home, set deep among the heather, she will soon turn an appreciative ear to his carolling.

Hosking



Hosking

AT HIS FRONT DOOR

This fine cock wheatear is sitting at the open mouth of the burrow in which his nest is situated. The picture shows to advantage his fine marking, bright grey-blue with black eye-patch, wings, and tail, while his upright bearing intensifies his appearance of general trimness.

birds have given rise to much argument, for it has been noticed that the individuals that pass on differ in a few particulars from those that stay here; in this case our residents may be divided off to form a local race, often on grounds that to the beginner seem very obscure and doubtful. An example of this is the Greenland wheatear, referred to later in this chapter.

Winter Visitors to Britain

Our winter visitors are neither so numerous nor so well known as the members of the last group. Some of them are also resident and may even be summer visitors as well. They include a number of members of the finch tribe, and many waders, ducks and other birds that breed far north. The same may be said of the passage migrants in general. These are birds which breed, probably, to the north, but are not satisfied with our climate during the winter, and fly straight through to the south of France, say, or the north coast of Africa. Often a number of individuals may remain throughout the winter, or even through the normal breeding season, instead of passing on to their usual wintering or breeding haunts, a proceeding which may lead eventually to one or two pairs settling to breed, and thus to an extension of the bird's range and an addition to the list of our residents. Flocks of some of our common birds may be seen in the country when one would expect them all to be hard at work nesting; elsewhere we see solitary birds of prey waiting till death provides a vacancy in a particular territory.

Both these examples point to the fact that there are more birds than suitable breeding places, and so the younger birds must wait until there is room. This fact is demonstrated strikingly by well-authenticated cases of one of a pair of hawks, say, being shot by a gamekeeper, who is astonished to find within a day or two that a new bird has arrived to settle with the bereaved mate; this may go on until one nest has had several different pairs of birds all looking after the original family one after the other.

Brook

FOOD FOR THE FAMILY

Though not so brightly coloured as her spouse, the hen wheatear is none the less a handsome bird in her own way, and she preserves the same distinctive bearing which is so characteristic of the species. Here, perhaps, she has the added feeling of pride for the family, which is snugly hidden beneath the rock.

How the solitary birds, often living many miles from the nest, can know that their presence is needed by the one parent who is left, is a totally unsolved mystery. Another most interesting point with regard to birds of the passage migrant group is that they seem to have no reason, in many cases, for ever visiting a country that is many hundreds of miles off the direct route from their winter quarters to their breeding grounds.

The members of the last two groups can be dealt with more simply. First, there are the birds that have wandered to the outskirts, usually, of the British Isles, perhaps through some upsetting of their directional instincts, perhaps through the agency of some storm, perhaps through meteorological conditions of which we have no record.

Finally, we have records of immense irruptions, as they are termed, of foreign birds that seem to have overflowed their breeding grounds and been forced to the British Isles in a desperate effort to extend their breeding range or die in the attempt. Some species invade us from time to time in small parties, staying the winter and then returning to their normal haunts; this migration of a few birds, apparently intentional, though outside their normal range, is yet another of the many problems that any observant naturalist who keeps a note-book may help in the end to solve.

Who's Who Among the Spring Arrivals

SOME slight description of some of the commoner of our regular summer visitors may be of value to the rambler who is a-field in early spring. Most of the birds given below are described in detail elsewhere in their character of summer residents, and at the same time the commonest of our spring arrivals are purposely omitted since they will have full chapters devoted to them later.

One of our most outstanding spring migrants, and one that is often the earliest to arrive, is the wheatear. If, on a day in late February or early March, we are walking on the South Downs or any bare part of the southern coasts, we may often notice the cock wheatear, for he is a striking and handsome bird in his fine spring suit. The first thing that attracts attention to this bird is the brilliant patch of white on his rump, spreading over the tail-coverts and the base of the tail. The forehead and the stripe over the eye are also white, and the back is typically pearl-grey, though in a bright light it may seem a most brilliant clear blue. There is a black patch running past the eye, and the underparts shade from buff to cream and gradually into the white of the tail. The wings are dark, and the tail itself is black. The female is duller, being sandy brown above and duller cream-coloured below.

A RATHER nervous bird, the wheatear flies along in front of the rambler, stopping on a stone wall or bush, jerking his tail and showing off the brilliance of his tail feathers. The female also has the white rump, so that there is no mistaking her either, once one has got to know the bird. The Greenland wheatear, one of the typical passage migrants, is a larger bird, more brightly coloured, and arrives later than our own species.

A near relative of the wheatear, but one that arrives a month or more later in the year, is the whinchat. A nervous little bird, of the same typically upright carriage that shows them both to be not distant relatives of the thrushes, the whinchat is extremely handsome, although the colour scheme is perhaps not so striking as that of its larger cousin. The back and upper parts generally are brown, with such marked black stripes on every

RETURNING RAIDER

The polly-wash, wally-wagtail, or as it is more correctly if more prosaically called, the pied wagtail, is one of our most distinctive birds. This photograph gives us a glimpse of the domestic life of this popular migrant, for the bird is bringing food to the youngsters in the nest built in the stream bank.

Crook

O. G. Pike

HIGH WORDS

These whinchats appear to be having a slight domestic argument, for the female (on the right) seems to be asking for the luscious beetle really intended for the young in the nearby nest. The male, perched firmly on the fir twig, displays the fine marking which makes him a conspicuous figure on his native moors and commons. Whinchats generally arrive in March or April.

feather that the appearance is dark. Cheeks and ear-coverts are black, as in the wheatear, and above and below this patch there are white stripes which help to distinguish the bird. The outer parts of the tail feathers are white; so are the base of the tail and a patch on the wing, though the former is only noticeable in flight; underneath the whole bird is a rich reddish, which gradually shades into whitish-yellow towards the tail. This is a bird very similar in habits and habitats to the wheatear, but whereas the former lays its eggs in old rabbit holes, the whinchat builds a small nest, well concealed in some tuft of grass or other cover in the open field.

Wagtail and Pipit Visitors

VERY notable among our spring arrivals are the flocks of wagtails and their near relatives, the pipits, which can be seen in large numbers along the south coast before they spread to their breeding places all over the country. The best-known of these is the pied wagtail, one of our most popular birds, and one that has a very large variety of names. The polly-wash, to give it its most popular nickname, is a very striking bird, black above, with a black throat, white face and forehead and snow-white belly. It flits to and fro on the lawn and over the fields, uttering the characteristic *tschizzick*, as its call has been interpreted, travelling with a graceful swooping movement in longish waves of flight. Its very near relative, the white wagtail, is a visitor to this country, but is so like the polly-wash that a very expert eye is needed to distinguish them; here again the local race is very possibly a sub-species of the continental.

The grey wagtail, though not so striking, is even handsomer; fonder of water than the polly-wash, it may none the less be seen on the coast at the time of its arrival. The head and back are a warm blue-grey; there is a white smear above and below the eye, and it has a black throat and brilliant yellow underparts. One might think that this should be called the yellow wagtail, but that name is reserved for our third common species; the greenish-yellow back and brilliant saffron underparts make this bird of the water meadows very conspicuous, while its note and its flight show us at once that it is another of the wagtails.

CLOSELY related, and also betrayed by flight and note and by their general slim build, are the pipits, of which we have also three common species. The rock pipit, the commonest bird of our shores, is best described as the small brown bird which flits uneasily along in front of us as we walk beneath the cliffs where it has made its home. Never quite allowing us to catch it up, it keeps just in front, uttering nervous little cries; if we can approach it unawares it seems sometimes to play a game with the waves, running down to the edge to snatch a morsel of food and then retreating hurriedly as the foam comes swirling in. In plumage it is very like the meadow pipit, a similar and very common bird found wherever there is open country and grass or heather. Up from the herbage there flies a brown bird that sings as it rises, then settles and eyes us nervously, for the nest is hidden deep in the grass and may easily be trodden on. A single alarm note calls up the female, who joins her mate in an anxious crying of the same note until we are well out of sight.

On the edge of a wood, or where there are trees with open country round them, a third similar bird throws itself upwards from the outermost bough, bursting into a song of sudden and surprising sweetness. A late arrival, coming, like the meadow pipit, in April, the tree pipit is a tree-lover with an eye for the open country and, as such, is essentially a bird of the park rather than of the deep wood or the moorland. It is larger than the meadow bird, from which its habitat and song alone will suffice to distinguish it.

All the time that these birds have been arriving others have come over, too, and by the end of April the majority of our summer visitors are here. The warblers, chief songsters of the summer, have almost all arrived; they will be described in later chapters, as will most of the other migrants. It may be remarked here, however, that, to see these birds at their earliest, one should visit the combes and valleys near the sea, where, after spring gales from the south and west, we may find, in the bushes and along the hedgerows, innumerable little visitors twittering in the cover that shelters them after, it may be, hundreds of miles of storm-tossed flight. Wheatears, whinchats, wagtails, warblers, shrikes, tits, and all the other tiny friends that go to make our summers glad are to be found, often so weak that we can take the opportunity to examine them in a way that will be impossible when they have recovered their strength, found mates and settled for their few months' sojourn in this country.

When they leave Britain on their return journey in the autumn, the migrant birds go in families, sometimes in great companies, and we have no such opportunities of close examination as are afforded in spring. It is for this reason that the arrival of spring birds takes us by surprise, whereas in autumn we see them assembling for weeks before they depart. Then, suddenly, they are gone.

LOOKING AT LIFE THROUGH A LENS

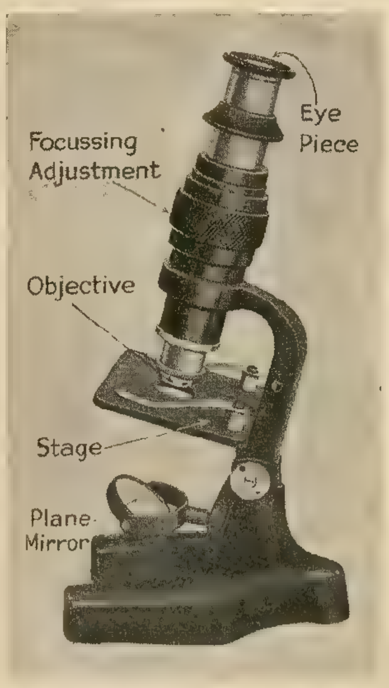
IN every other section of this work we are concerned with what may be seen with the naked eye. But what the eye, even the most highly-trained eye, can see is but a fraction of what lies hidden in the realms of the infinitely-small. We must have resort to the microscope to explore the depths of this wonderland, and something of what the lenses reveal is described and pictured in the series of which the first chapter appears below

FOR many years the delights of viewing the minute mysteries of Nature with the aid of a microscope were limited to the professional scientist or to those able to pay the high price of a good instrument. Nowadays, however, many firms have produced instruments well worthy of the name of " microscope " yet costing only a few pounds.

Whatever the make or price of the instrument, all optical microscopes work on the same principle and are similar in appearance. The picture in this page shows what a microscope looks like and the names of the various parts are also given, so that it is not necessary to enumerate them here. The simplest form of microscope consists of a magnifying lens situated at one end of a tube and another lens at the other end acting as the eye-piece.

Objective and Eye-piece

THE lens nearest the object that is being examined is known as the *objective*, while that at the other end is called the *eye-piece*. The objective is undoubtedly the most important part of the whole instrument, and may consist of a great many lenses of different powers and properties, according to the type of work for which the microscope is required. It is the function of the objective to collect the rays of light coming from the object and to bring them together inside the tube to form what is known as the focal image. This image within the tube is then transferred through the lenses of the eye-piece to the eye of the observer.



REVEALER OF SECRETS
This comparatively inexpensive telescopic microscope gives a magnification of 25 to 200, and is an excellent instrument for general use.
Negretti & Zambra

Below the objective there is a mirror, which can be moved about so that the rays of light from a window or electric lamp may be concentrated on the object from behind. Between the mirror and the objective there is always a platform on which the glass strip, or *slide*, carrying the object can rest, and where it can be fixed in position by means of a spring clip or screwing apparatus. In order that the lenses in the objective may be focussed on the object, the tube is fitted with an adjustment screw by which it can be moved up and down. On some of the very cheap microscopes this screw is dispensed with and the tube is clamped in such a way that it may be moved up and down by hand, but will not move through any sudden movement on the part of the observer or by the force of its own weight.

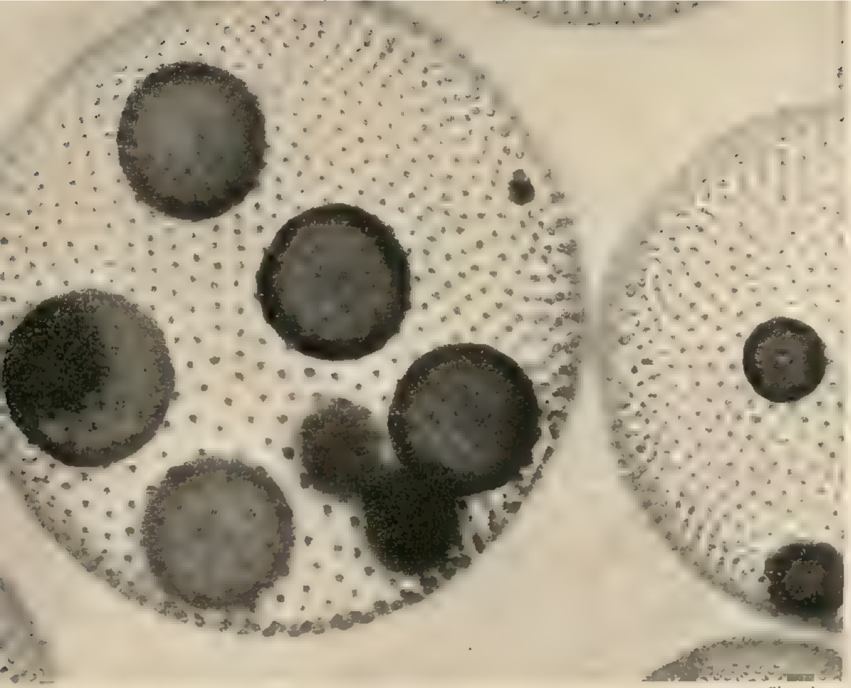
The professional microscopist uses various methods to make the different parts of his object stand out in relief from one another. If biological specimens are stained with a dye, only certain tissues " take " the dye, leaving the others uncoloured. A mineralogist uses polarized light in his microscope for the same purpose. In this way the different minerals in the thin section of rock which he examines take on the various colours distinctive to them on the spectrum scale.

For the amateur, however, such elaborate preparations are unnecessary, and once the working of the instrument has been thoroughly mastered it is best to try the microscope for the first time on an object which does not need a very great deal of preliminary work. The leg of an insect placed in a small drop of water on the slide and examined with plenty of light makes an extremely interesting subject, and the beginner will be astonished at the great pincers, the thick joints and the numerous hairs with which it is provided. Butterfly wings also make good objects, as do sections of spider webs, flower petals, or animal hairs.

Protoplasm in a Leaf

ANOTHER interesting and more instructive specimen can be made from the underside of any leaf, if cut in a very thin section, either across (known as a *cross section*) or lengthways (known as a *longitudinal section*). In these specimens almost the first thing that will be noticed is the cellular formation of the tissues. The whole of the circle of light seen through the microscope (the *field*) is covered by a series of little partitions containing minute lumps of green pigment and a jelly-like substance which adheres to the sides of the cells. This series of partitions gives the observer a very fair idea of the complex cell structure that is the foundation of the leaf.

The substance within the partitions is known as *protoplasm*; it is the foundation of all living substance and is found in the cells of every plant and animal. Protoplasm cannot, however, continue to exist without the presence of the nuclei, those repositories of all inherited characteristics (see page 1296), so interesting to



Cheavin

MARVELS OF THE MINUTE

Above: *Volvox globator* (×130), a lovely green sphere seen rolling through pond water, is a colony of unicellular animals. The dark circles seen within the sphere are daughter colonies in process of formation. Right: a flinty shell formed by a radiolarian, or marine protozoon (×500).

scientists, but if the nuclei be removed the protoplasm at once dries up and all the natural features of living matter disappear.

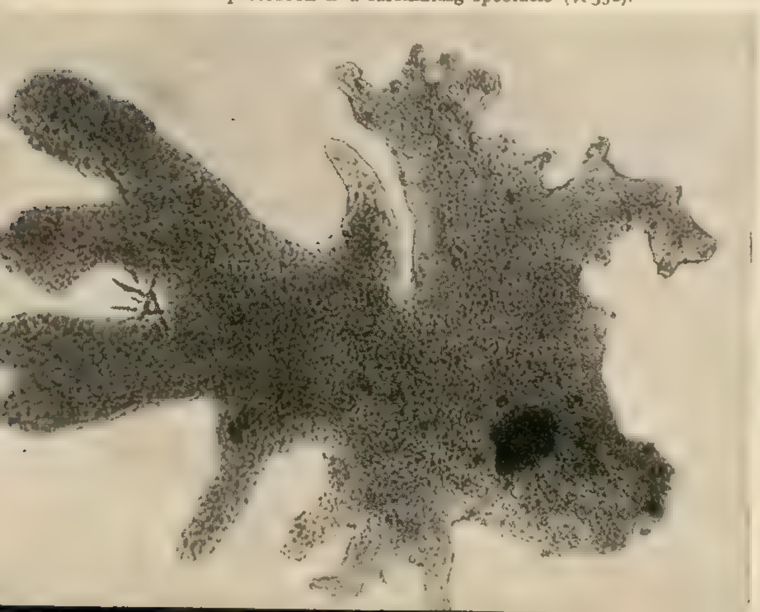
From examining the protoplasm in the living cells of the plant leaf, a natural step is to look for the free-living protoplasm to be found in the water of a pond. In the form of the tiny organism known as amoeba this jelly-like unit of life may be seen if a drop or two of dirty pond water be put on a slide and looked at through the microscope. It will appear at first as a blob of white jelly, which can be seen rolling itself along through the water on the slide in a manner almost comic. First it sticks out in front of it a blunt feeler, which seems rather to flow from the volatile body than to be deliberately extended. By means of this feeler, or *pseudopod* (Gr. *pseudo-*, false; *pous*, foot) as it is called, the amoeba is able to let its body flow forwards in the direction in which it wishes to go, and then, by extending the pseudopod once again, it can continue its journey in a similar way.

There is, however, another use for these arm-like extensions of the amoeba's body, for, having no mouth, no eyes, and virtually no organs of any kind, the amoeba is forced to search for its food entirely by means of its pseudopods. These it extends, and if they come into contact with anything, whether edible or not, they at once surround the object with protoplasm, and then, the pseudopods being once again retracted, the piece of food or extraneous matter is drawn into the very centre of the amoeba. The natural juices of protoplasm act upon anything which can be made use of as food, and after a while the waste matter is expelled in the same manner in which it was absorbed.

Like the protoplasm in the cells of the plant leaf, amoeba is not all solid protoplasm, but has also a nucleus. This may be seen, under fairly strong magnification (about 150×), as a black spot in the centre of the organism. An interesting experiment can be carried out if the amoeba is cut in half with a very sharp knife. It will be noticed that the blade, however sharp, will not cut the nucleus, but always slides to one side or the other. In this way two amoebae can be produced, one with a nucleus and one without. If these two are left for a short time, the one without the nucleus dies, while the other goes on living as an amoeba in the ordinary way, replacing the missing portion of protoplasm after a few days only have elapsed.

LIFE'S SIMPLEST FORM

How *Amoeba* looks under magnification. In this photograph of an amoeba the granular protoplasm, the dark nucleus, the darker portions of ingested food particles, and the blunt pseudopodia are all clearly shown. The continual change in shape of this protozoon is a fascinating spectacle (×350).



Revelations of Teeming Life

AMOEBA is by no means the only form of life to be seen when a drop of pond water is put under the microscope, for there is almost certain to be a very large number of different organisms swimming and rolling themselves about, some covered with hairs (known as *cilia*), and others with long feelers. But apart from the life to be seen in this way, there are numerous other ways in which a microscope can be utilized.

WILD RED DEER OF MOUNTAIN AND MOOR

THE largest of the wild fauna still surviving in the British Isles is the subject of this second chapter in the "Wild Animals" series. Some reference is made to the tame deer to be found in our public and private parks, but attention is concentrated on the wild red deer which have their principal habitats in the wild moorlands of the West Country and the Scottish Highlands

THE largest and undoubtedly one of the most interesting of our wild animals is the red deer, which nowadays has a somewhat limited range, being found principally in Scotland and Westmorland in the north, and on the desolate moors of the West Country in the south. Quite a number of herds are to be seen, however, in the private and public parks in various parts of the country, as well as among the ancient trees of the New Forest in Hampshire. In their really wild state deer are dying out in England, and though they may survive for years yet in the remote fastnesses of the Scottish highlands, their eventual extinction, so far as Britain is concerned, would seem to be certain. In the New Forest, although a very few still remain, they have been long officially extinct, for by an Act of Parliament of 1851 the extermination of all New Forest deer was decreed, because they destroyed such vast quantities of young shrubs and small trees, which in modern times are of far greater value than venison, as the flesh of deer is called.

WITH ALL THE 'POINTS'

From the earliest days of stag-hunting hunters have given names to the various parts of the antlers. A full development of "points" includes the brow, bez, and trez, which, with three on top, makes a "Royal Stag" such as the one seen above. The brow and bez together are sometimes called the "double-brows."

FROM the very olden days deer have been hunted and killed in large numbers within our shores. From the twelfth century onwards the kings and barons began to monopolize the hunting, and great sections of the enormous forest which stretched from the south of England to the Highlands of Scotland were set aside for the breeding of deer. By the sixteenth century, however, in spite of every effort made to maintain the supply, deer became increasingly scarce south of Yorkshire, and the hunting districts were gradually confined chiefly to the moors and mountains of the north of England and Scotland.

The full-grown male deer are known as stags, and stand about four feet in height at the shoulders; the females or hinds are somewhat smaller. Deer of all kinds vary considerably in appearance according to sex and the time of the year. In all British species of deer only the males carry horns, and in the red deer these are dropped annually about the last week in March. The actual date, however, depends largely upon the physical condition of the particular stag; if the deer is in any way unfit or out of condition, he may retain his horns until almost the end of May.

A STAG shedding his horns is a sight that even the most experienced of deer "stalkers," as the deer hunters of the Highlands are called, may never have had the good fortune to observe for himself, but from accounts of those who have been so privileged it appears that the horns first incline leisurely to one side and then drop to the ground. The stags then toss their heads in the air, and as soon as they are completely free of the antler-remains they jump up and down as if in sport and speed away to a hiding-place in the forest or among the bracken.

It has been stated on excellent authority that the hinds often chew the discarded horns of the males, and in support of this theory many horns have been produced which have quite clearly been chewed right down to the base. The body of a hind was once found with part of a horn sticking in her throat.

Soon after the horns have been discarded the new ones begin to grow. During the period of growth, which occupies about five months, they are covered with a continuation of the soft skin of the head, which, with its mass of short hair, is known as the "velvet." When the actual bony core of the horns has attained its full size, solidity and hardness, the growth of a rough bony structure at its base presses on the blood vessels of the velvet, thus preventing the supply of blood from reaching the skin covering. The skin therefore dies, and the deer tears it off in strips by rubbing his new horns against trees and in the heather. After it has all been discarded, he is once more ready to meet any newcomer in battle.

Valentine

THE STALKER SEEN

Although the deer's sense of smell is very highly developed, these three beautiful stags have obviously seen rather than scented the photographer who has stalked them upwind. The wild scenery of the background (the photograph was taken in the Cairngorms) is typical of the habitat into which the red deer of Britain have been driven by the advance of civilization.

A stag is said to be "in condition" as soon as its horns are "clean" of velvet, and about two months later the mating time, or "rutting season," begins. In the early autumn the young stags select their mates, and if two happen to choose the same hind a violent fight invariably follows. The stags are now in the prime of condition, with their long, well-branched horns, and fine ruffled necks covered with a thick mantle of long, brown hair. One stag with sharper or larger horns than the rest will collect for himself a large number of hinds and will walk round his herd "belling" to frighten away his rivals, who will often endeavour to steal away one of his ladies if he happens not to be looking. The life of a big stag during the mating season is, indeed, a time of incessant watchfulness and unrest. The smaller stags are always on the look-out on the edge of the big deer's harem for any opportunity of sneaking in when the attention of the lord of the herd is otherwise engaged.

If the frosts of winter come early it frequently happens that the stags are in no condition to face the prolonged spell of cold weather, and many of them suffer great privations as a result and are often killed off. Falls of snow on the mountainsides in Scotland sometimes bring about avalanches, and old Scottish tales tell of as many as two dozen deer being killed in this way at once.

Calving in Solitary Places

In the spring the hinds separate from their fellows and, having found a sufficiently lonely spot, either among the trees of the forest or in the bracken of the moorland, give birth to their single calves at the end of May. The baby deer is covered with fur, and its back and sides are always dappled white, as is the case with the adults of the fallow deer. After calfhood—which lasts about eighteen months, so that a mother may frequently be seen with two calves at her side, one a year older than the other—this spotting disappears. The mother leaves the "fawn" (deer calf) concealed during the day and visits it early in the morning and late at night.

Deer are found as natives in nearly every part of the world except South Africa and Australia, and about sixty different species are generally recognized. All species belong to what naturalists call the even-toed ungulates (Lat. *ungula*, hoof), i.e., those animals with divided hoofs. The footprints of the deer are known by stalkers as the "slot," and these can be seen very clearly in damp soil

PRACTICE MATCH

These two young stags with undeveloped antlers are engaged in one of the friendly combats which not only form a natural part of their play but teach them the art of fighting, in preparation for the really serious battles of life and death which take place when the hinds are selected after maturity.

if looked for in the right places. When trying to track wild animals the footsteps, or "spoor," should always be sought; and in the case of deer in particular the animals must be approached "upwind," that is, in such a way that the wind carrying the scent of the tracker is blowing away from the deer.

The teeth of the deer are arranged in the same manner as those of the sheep or the ox, for, like these animals, the deer is a ruminant, living on vegetable food and having a four-chambered stomach. There are no teeth in the forepart of the upper jaw, the three "molars" and "premolars" being placed well back in the cheeks. On each side of the lower jaw there are to be seen in front three "incisors," or cutting teeth, which bite against the hardened gums in the upper jaw. The stags have small "canine" teeth behind these, but in the females these are missing. Three premolars and three molars bite against each other in the upper and lower jaws.

Dentition of the Deer

THE arrangement of the teeth of any mammal may be expressed by what is known as a "dental formula." Starting from those teeth to be found in the very front, known as the incisors, we find next the canines, or eye-teeth, and at the sides the premolars and the molars. In describing the number of teeth in any species a formula is used in which i=incisors, c=canine, pm=premolars, m=molars, and the numbers on the top line represent the teeth on one side of the upper jaw and those on the bottom line the teeth on one side of the lower jaw. Thus the dental formula of the red deer is:

$$i\,\frac{0}{3},\ c\,\frac{0}{1},\ pm\,\frac{3}{3},\ m\,\frac{3}{3}=32,$$

this figure of 32 being 16 doubled, to account for the teeth on both sides of the head.

Berridge

IN VELVET

A young stag is here seen with his new antlers "in velvet," to use the vernacular of the stalker. The soft, hairy skin which covers the horns in the early days of their growth peels off in strips as time advances; and the stag is said not to be "clean," and therefore "game," until every trace of skin on the horns has been rubbed off in the heather.

A. R. Thompson

ANTLERED MAJESTY

This beautiful six-year-old stag is typical of his kind. Although the breeding season is over and snow covers the ground, his antlers still make a fine showing as he raises his head to take the scent from the wind, and stands ready to meet any possible attack from an unseen foe.

The food of deer is herbage and the young shoots of trees, and in consequence they may do great damage in afforested districts such as the New Forest and also on agricultural lands; a whole field of roots, for instance, can be ruined in a night if attacked by a herd. Wheat, potatoes and cabbages may also be ravaged by deer, but in the woods their food consists largely of toadstools, acorns and chestnuts.

Truants from Whipsnade

AFTER the out-of-doors section of the London Zoological Gardens was opened at Whipsnade, near Dunstable, the parks in the surrounding district were stocked with many different species of deer. It was not long, however, before the majority of these escaped into the neighbouring estate at Ashridge, and wandered off into the miles of bracken and gorse-land under the care of the National Trust. On land under the Trust's jurisdiction it is

done in a few hours to a field of roots. Although there are few who are prepared to argue that these lovely animals should be killed off by the aggrieved farmers, it may be doubted if the economic condition of agriculture in this country is so flourishing as to allow of the continued existence of deer in an unrestrained state in an agricultural district.

CAUGHT IN THE ACT

Made venturesome by hunger, this young red deer has left its native heather-covered hills, seen in the background, and has come down into the valley to seek for food in the fields cultivated by the farmer. Standing on the top of a haystack and silhouetted against the shimmering waters of Loch More, the fawn made an excellent subject for the hunter with a camera.

STAND-UP FIGHT

The deer seen in this remarkable "snap" are not dancing, as might perhaps be supposed, but seriously engaged in a first-class "scrap." The cause of the quarrel would seem to be the appropriate division of the locust-beans which a kindly-disposed keeper has made available so as to keep the deer alive through the hard winter months.

illegal to shoot game of any kind, and hence the deer on Ashridge common have been enabled to breed freely. As a result their numbers have so increased that local farmers have been forced to complain to the Trust Committee of the almost nightly depredations made on their crops by the deer.

Coming down from the bracken and gorse-covered common, the deer have been known to clear whole fields of young, green corn in a single night, while many hundreds of pounds' worth of damage has been

HOW DEER ARE STALKED

Whatever views one may hold on the subject of blood-sports, the healthy, exciting and wholly fascinating recreation of deer-stalking may be enjoyed by all who live in the vicinity of wild country where deer range over the countryside. The fun of the game lies almost entirely in the process of stalking, and, if not actually fired at with a rifle, the deer may at least be "shot" with a camera.

As has been explained already, all animals must be approached upwind, or on "the side" of the wind, so that they cannot get a scent of the stalkers. Deer can "take" the scent of a man at distances varying from a few yards to as much as two miles if the wind is in the right direction and the formation of the land suitable. In even a very moderate gale it is therefore unsafe to pass within a mile of a herd situated down-wind, and often very long walks have to be carried out before a wide enough détour can be made.

Approaching the Herd

If a herd is resting on a hillside, the largest of the stags invariably conceal themselves near to the foot of the hill, with the smaller stags and the hinds lying behind them. The herd will, of course, be on the lee side, so that they are sheltered from the wind, and in this situation it is well-nigh impossible to approach them without either being seen coming up the valley from below, or scented coming down the hillside from above. There is only one way in which deer in this position may be viewed from a short distance, and that is by stalking them "crosswind," advancing in a diagonal direction down the side of the valley. There is, however, no standard law on which the deer-stalker may depend, care, common sense and an indefinable instinct being his stock in trade.

RUGGED SYMBOL OF BRITAIN'S GREATNESS

For centuries the oak, so gnarled and weather-beaten, so deeply-rooted in the soil, has been taken as typifying in completest measure the British character. Thus Scott wrote of soldiers whose " hearts were made of English oak," Garrick boasted that " Hearts of oak are our men," while Burke in one of his grandest passages spoke of the protecting shadow of the British oak. Below we are given an insight into the life-history of this much-praised monarch of the forest

Deservedly taken as a symbol of strength and endurance, the oak is at the same time a tree that has its share of that delicate beauty which is more usually associated with such trees as the ash and the birch. To the qualities which make it a favourite with the timber merchant it allies a rugged beauty that is all its own, and at certain seasons of the year it may surprise us with the delicacy and lightness of its foliage and flowers. Besides these features, obvious to the eye of the rambler or naturalist, the oak has an added attraction for the antiquary, the historian, and, in fact, for anyone who is at all interested in the ways and customs of the English countryside. No other tree is so closely related to legend and ancient rite as is the oak, the monarch of the forest and the pride of its native land.

Although to the casual passer-by an English oak is an easily recognizable, unvarying tree, yet to the botanist it may be one of several varieties, based on differences of leaf and flower that will be described later in this chapter. To the timberman, too, the oak is not merely a tree from which he may reasonably expect to obtain a certain amount of timber of definite quality. The wood varies enormously in value, according to the soil on which it is grown, as many an unfortunate landowner has discovered to his cost, when the merchant has explained that his oaks have proved a worthless investment.

It may seem superfluous to give any detailed description of so well-known a tree as this, but the main features of the leaf and flower are noted below in order to enable the naturalist to distinguish between the various subspecies that have been created, on more or less sufficient evidence, by the botanists. The typical oak leaf is ovate in shape, but is normally so deeply lobed that this form is lost. In summer the leaves are dark green, hard and shiny above, rough and slightly paler below, but in spring they cover the tree with a delicate yellow-green bloom. In many parts of the country the change of the oaks from the grey-brown of bare twigs to the sudden yellowing of the bursting buds marks the change from winter to spring as surely as does the appearance of the first primrose in the hedgerow.

The leaves show the features which distinguish the varieties of the tree referred to above. In one form, known as the sessile oak, the leaves have a footstalk of

Bastin

MALE AND FEMALE FLOWERING OF THE OAK

The left-hand photograph shows the tassel-like catkins that bear the male oak flowers. Golden-green in colour, they impart added beauty to the trees in spring, appearing, as may be seen from the picture above, at the same time as the tender young leaves. The female flowers, shown in the top right-hand picture, are borne, a few at a time, on short, stiff, upright stalks. Turning back to the photograph of beech flowers in page 51 the same feature of hanging stems for the male flowers and short stiff stems for the females will be observed. There is one noticeable difference, however, for in the oak the flowers grow separately. The lower photograph on the right shows a female oak flower cut in section and enlarged about twelve times. The little scales round the outer edge will in time coalesce to form the acorn cup, while the acorn itself will be developed from a minute seed inside the ovary.

Bastin

FRUIT OF THE OAK

In former days acorns constituted one of the staple foods for the small-holders' pigs, but they have been long discarded in favour of more nourishing and economical provender. Those shown above are from the oak known as the pedunculate, because of the peduncles or stalks on which the flowers are carried.

from half to one inch in length—the term sessile refers not to the leaves, but to the flowers. In the pedunculate oak, on the other hand, there is no leaf stalk, or scarcely any, and the base of the leaf is broad. This form is found in the south of England, on low ground and in sheltered valleys, while the sessile oak is fonder of high ground, facing the south and west. An intermediate form, the Durmast oak, has short leaf stalks and down on the undersides of the leaves. These varieties are to be distinguished from the Turkey oak and the holm oak, completely separate species that will be dealt with in a later chapter.

Characteristics of the Oak Flowers

MALE and female flowers are of distinct types, growing separately; they appear in April or May. The males are in clusters, each flower being borne sessile and a number of clusters being found on a single stalk. The stalks hang downwards, and when the flowers are at their best an oak tree has a decorative effect which one would never expect from the general reputation of solid strength which is more usually connected with it. The flowers, which are green, consist of a calyx of from four to seven lobes, and ten stamens. The female flowers are borne on short, stiff stalks, which grow from the main twig, just above the male catkins. These female flowers grow two or three on a single stalk ; they are green in colour.

In the flower, the acorn cup is represented by a series of little green scales which surround the calyx. The acorn is the ovary, which in the flower is surmounted by three styles. The ovary itself is actually three-celled, and each cell contains two ovules or seeds. We should, therefore, expect the oak fruit to consist of six kernels or seeds, but normally only one survives, though occasionally we find an acorn with two kernels. The acorns are on a very short stalk in the sessile oak and the Durmast oak, and on a long stalk in the pedunculate variety.

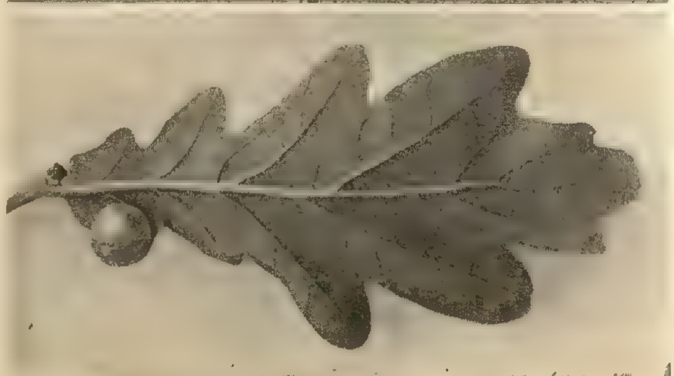
The acorn itself consists of an outer casing, which surrounds the hard, white kernel, from which the tiny oak seedling develops. Oaks can very easily be grown from acorns, and it is a simple matter to grow one's own trees, starting them in flower pots.

It is in its bark and its manner of growth that the oak tree shows best its characters of strength and solidity. The trunk, which rises normally as a single, thick bole, is covered with greyish, deeply furrowed bark, the furrows being smaller than in the elm bole, but deeper than in the ash. The bark itself, moreover, is very hard, and where in the elm we can break off the ridges between the furrows, in the oak they defy our efforts, and when it comes to cutting the tree, the bark blunts the axe before ever we reach the wood. On young trees and on the outer branches, the bark is smooth and shiny, greyish-green in colour.

Height Determined by Habitat

AS we find with so many of our trees, the oak assumes a very different form when it can grow free in the open from that which it has when it is forced upwards in the confines of a thick wood or copse. In the open the oak is often broader, from tip to tip of its branches, than it is high, for its height is usually seventy to eighty feet ; whereas in the thickness of a wood, where the competition of its fellow trees forces it to send up a single, straight trunk, it may be as much as a hundred and thirty feet in height.

Grown in the open, it shows itself rather square in outline, the big branches running out horizontally about twelve feet or less above the ground, and others doing likewise at frequent intervals up to the top of the trunk. Sometimes, if conditions are not entirely suitable for regular growth, it will send out a single huge branch, which is as large as the main trunk, or even several of



Hosking

INSECT TENEMENTS

The galls shown above are amongst the commonest of the many types found on oak trees, and both varieties are from time to time miscalled oak-apples. The correct designation of those in the top photograph is marble galls; they are the self-made homes of tiny gall-flies, which have escaped through the holes in the sides. In the lower picture we see a fine specimen of a leaf-gall such as is often found on the under-surface of oak leaves.

ANCIENT OF THE WOODS

This is one of a number of magnificent oaks that were sold for timber at Rugeley in Staffordshire not long ago. It shows to perfection the really characteristic feature of the oak—the way in which the lateral branches grow straight out from the trunk without affecting in the slightest the balance of the tree. Notice the bases of the huge roots that like mighty buttresses keep the trunk firm in the ground.

these branches, so that the whole tree seems absurdly top-heavy and bound to fall over. It is seldom, however, that the oak suffers from winter gales, and all over the country we may see grand old trees that have gradually died away, with perhaps the loss of an occasional branch, where weaker giants such as elms would long ago have paid the penalty of old age and too great a weight of branches. One of the reasons for this is that the oak has an unusually efficient root system, consisting of a long tap-root, which descends straight down into the soil and sends out innumerable side branches that help to anchor the tree firmly in the ground.

Rivalry of the Oak and Beech

It is of interest that the only enemy the oak has which seems able really to stop its career is the beech tree, for where the two are competing in shallow soils, the beech, with its wide-spreading root system just beneath the surface, takes all the good from the soil before any of the valuable salts have time to reach the oak, and the latter is thus frequently starved out of existence at an early age. Where the soil is rich and loamy, however, the two trees may flourish together, although there is no doubt that the oak is liable to suffer if ever there is a deficiency of food. Sometimes, too, where the roots of oaks in a wood have all reached poor soil, the trees die off gradually from above.

The growth of the oak is slow, a fact which accounts in large measure for the weight and fine lasting qualities of the wood. A further feature which gives to certain pieces an exceptional value is that the branches often grow in a curiously curved manner, which makes them admirably suited to the requirements of boat-builders, who find in the elbow-shaped pieces the exact shapes needed for the stems and "knees" of boats. This quality is, of course, of less value than formerly, when the ships of both armed and merchant fleets were built of wood. In recent years the oak has been revived as a furniture wood, since new methods of working and preparing the timber have enabled cabinet-makers to use the fine graining and colouring of the wood to better advantage. Oak was, of course, the wood always employed in making all the furniture, both fine and ordinary, before the eighteenth century. Then came the age of walnut, then the introduction of such exotic woods as mahogany and satinwood, and now, after many years of neglect, oak is becoming once more one of the most popular woods for domestic and office furniture.

Much has been written about the age of oak trees, and it is certain that few trees live regularly to such great ages. Oaks of a thousand years and more are not uncommon, and the tree does not produce seed until it is sixty to seventy years old, nor is it mature, to the mind of the timberman, until it is at least a hundred and fifty. The size of some of the patriarchal oaks is hard to believe when we see it written down in cold print. The

Hosking

OAK SYMMETRY

Seldom does one come across an oak of such perfect proportions as this. Grown in an open park, with no other trees near at hand to stop its lateral spread, it has a remarkable symmetry which in no way detracts from its beauty—on the contrary, may be said to enhance it. The great branches start some feet above ground, leaving beneath them a fine straight bole.

Cowthorpe oak, for instance, was 54 feet in girth some feet above the ground, and trees of twenty-five-foot girth are common in such places as Richmond Park. A famous oak was that near Newport, in Monmouthshire, which gave to its buyer nearly 2,500 cubic feet of sound timber and six tons of bark. This tree was worth £600 to the merchant, and gave five months' employment to several men before it was all sawn up.

Batteners on the Oak

The oak tree is host to some five hundred different species of insects, which include among them some of the finest and rarest of our native species. The stag beetle lives in the wood of the tree, and the purple emperor butterfly dwells in its topmost branches, although it feeds as a caterpillar on the lowly sallow bushes. The hornet is most often at home in a hollow oak, and many a wild bees' nest is to be found in the cavernous depths of some of these great trees. The leaves of the tree, especially, are attacked by insects, and in many cases a tree may be completely stripped by the swarming larvae of such a moth as the mottled umber or the oak tortrix. Where a lesser tree would be killed, the oak will send forth a fresh set of leaves, although its growth may be a bit retarded, and the tree perhaps slightly weakened against adverse conditions.

Not only insects find a home in the great arms of the oak. Where branches have fallen off, leaving a scar, or perhaps a small area of soft wood, the nuthatch makes its nest; where the bark is thick and gnarled, or rent apart by lightning, or where a falling branch has split the trunk, the tree creeper is in its element. Every hole is a potential home for a pair of tits; every tall, isolated giant may support the mass of twigs that rears a brood of young crows; in a few favoured districts the oak provides a home for the grandest, most solemn, of all our English birds, the raven.

One of the most noticeable features of the oak is the enormous number of galls that are to be found on its leaves and twigs. Best-known of these are the marble galls, round, hard, brown objects that persist long after the leaves have fallen, and the soft, red and green oak apples, which are favourites with children all over the country. On the leaves, too, we find many extraordinary galls. All these are produced by various gall wasps and gall midges, insects that are for the most part seldom seen by any but the specialist.

Hosking

GOOD FOR TIMBER

This close-up view of the bole of the tree shown in the upper photograph in this page gives a good impression of the features for which the oak is so valued as timber. Straight and without twists, it is of even diameter, and has no suckers or small shoots to waste its strength. The rough bark is very noticeable.

In ancient legend and myth the oak is one of the foremost of our trees, and its relation with the ancient Druids is common knowledge. They planted oaks to form their sacred groves, they made the Yule log an oak log, and they used the leaves of the tree to wreath their foreheads. Under the oak tree their court was held, and many curious rites of the ancient faith were connected with the mistletoe, a parasite that grows pre-eminently on the monarch of the forest.

MONARCH OF THE TREES

Whether one of a forest group or set in a hedgerow rank, the oak is always a noble spectacle, fully deserving of its regal position in the silvan hierarchy. It is in the open, however, as seen in this photograph, that its full grandeur is revealed, for only then can we appreciate its symmetrical shape, its far-spreading boughs, its sturdy, firm-planted trunk. In such a situation it is free to grow to its full stature and remains sound and strong through many a century of storms

SNOWDROP GLADE

When despite the calendar's telling it seems that winter must remain with us for long months yet, the little snowdrop dissipates the damp gloom of the woodland with the bright showing of its pendulous, bell-like flowers

'DAFFS' IN THE BREEZE

Like the snowdrops pictured in the opposite page, the wild daffodil is a welcome proof of the arrival of spring. In such a setting as this it has little to fear from the rivalry of its much-praised, cultivated cousin

WEATHER'S INDELIBLE SCARS

Its towering cliffs topped by jagged pinnacles and its sides furrowed and fissured into fantastic shapes, Cheddar Gorge affords one of the most striking examples of the effect of weathering on carboniferous limestone

WEATHER'S WORK IN SHAPING SCENERY

AMONG geologists the word weather has a somewhat wider meaning than is given to it in everyday speech, for it is held to include all the elemental forces of Nature. Below we are told how the landscape of Britain has been, and is still being, modified by the weathering process

WHAT do we mean by weather? In a geological sense the word weather, or weathering, is used to include all those elements of Nature, such as heat, cold, wind and rain, which play their part in breaking up the rocks of which our land in all its varied appearance is made.

At first, it seems as though wind and rain could have little effect on the massive tors, bleak hills and rolling downs of Britain, but when the process of weathering is carried on through countless ages, aided by the extremes of temperature and certain chemical actions, the cumulative effect is of great importance in the making of landscape. The weather may be called Nature's landscape gardener, for through its agency mountains are levelled, hills rounded and valleys carved. If we examine this process carefully we can understand how it is effected and notice examples of the weather's work throughout the British Isles.

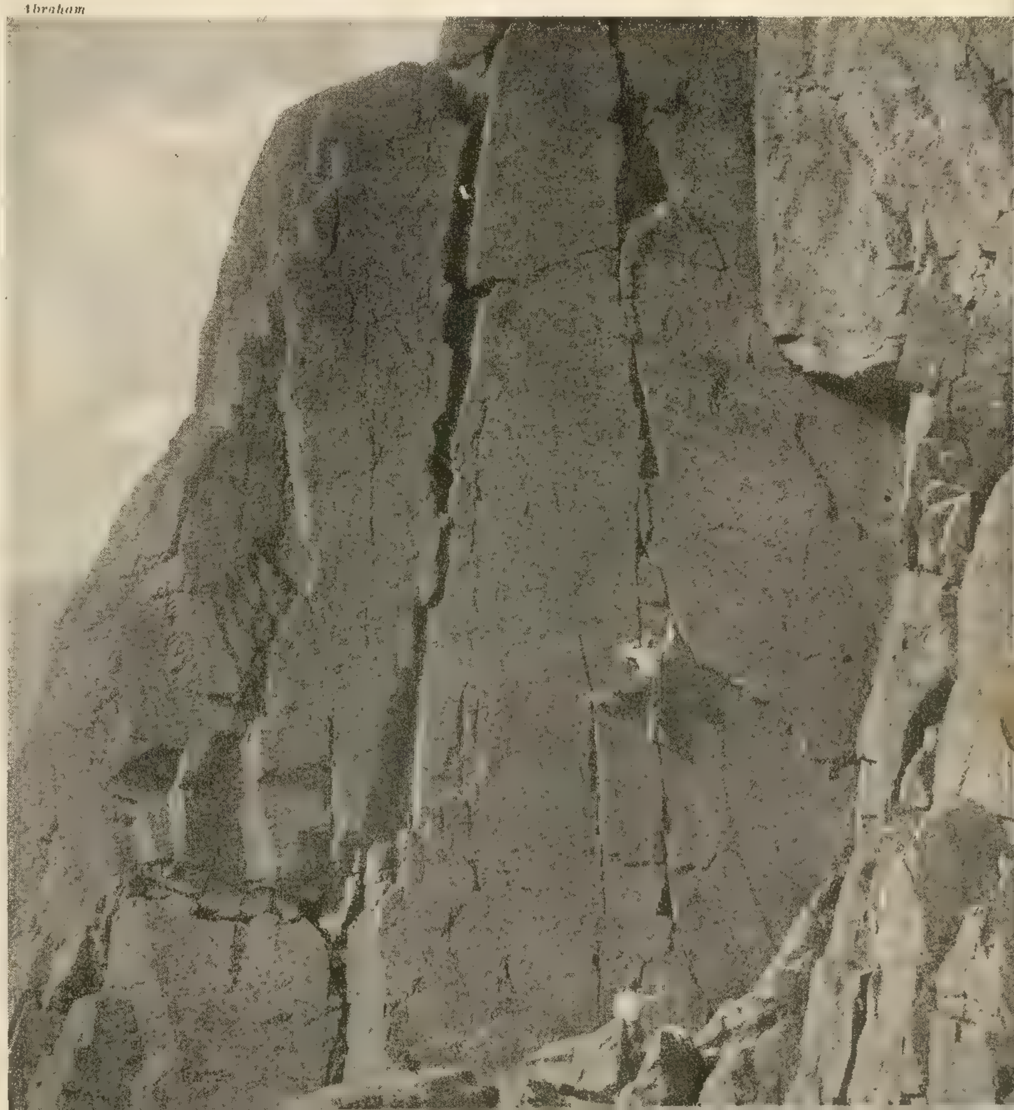
Wind and rain by themselves are powerless to weather the rocks to any great extent. The mere force of rain beating down upon a granite rock is negligible in its effect; even a soft clay will be only slightly pitted by the heaviest shower.

But the rocks themselves afford the means by which the weather can carry out its work. On careful examination, most rocks will show cracks that traverse them, some large, some small. These cracks, which are known as joint planes, were formed in different ways. Some, such as those that split up the Giant's Causeway into its hexagonal columns, were formed when the basalt cooled from its molten state; others, such as the big cracks in the tors of Dartmoor, were formed by the stresses and strains that the granite underwent in the depths of the earth; in sedimentary rocks, notably in limestones, the cracks appeared when the rock hardened and the loss of moisture necessitated a reduction in bulk, with consequent contraction and cracking.

RAIN, falling down upon these rocks, penetrates the joints and crevices and permeates the whole formation. Now, if the temperature is cold, the water in the cracks freezes. When water turns to ice it expands, straining the rock and widening the crevice in which it is held. When the thaw begins, the strain is relaxed, but the rock surface is loosened and fragments are washed away easily by subsequent showers. Fragments of rock and even quite large slabs can be seen strewn over the hillsides and moorlands, particularly in those parts where extremes of temperature are severe.

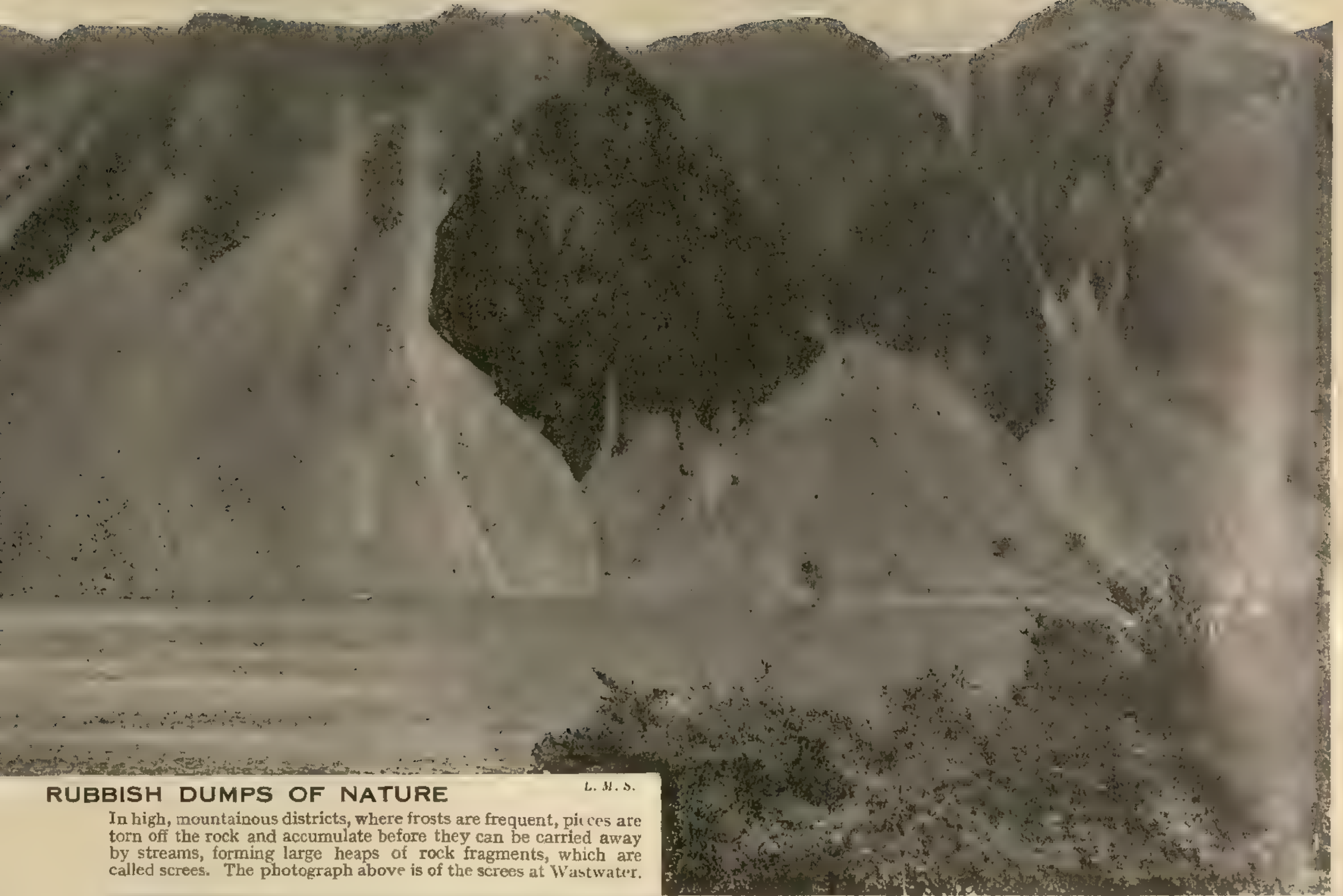
A particular form of this *mechanical* weathering, and one that makes a striking scene, occurs in certain mountain districts that suffer severe frosts. In these places fragments are broken off so rapidly that they accumulate before they can be carried away by rill, stream or river, and remain to form great mounds of rock débris. These mounds, which are known as *screes*, grow to such a size that they may cover a hillside from the bottom nearly

Abraham



JOINTS IN THE ARMOUR

This picture of a cleft in the famous Lake District mountain known as Great Gable shows three sets of joint planes at right angles to each other. These cracks enable the rainwater to penetrate the earth's rocky armour, freezing and flaking off fragments to expose fresh surfaces to the weather's attack.



L. M. S.

RUBBISH DUMPS OF NATURE

In high, mountainous districts, where frosts are frequent, pieces are torn off the rock and accumulate before they can be carried away by streams, forming large heaps of rock fragments, which are called screes. The photograph above is of the screes at Wastwater.

Dixon-Scott

WEATHERING'S DEBRIS

Rock surfaces exposed to rain and frost are continually being weathered, slivers, fragments and large blocks being broken o , and then littering the hillside (as near Barmouth, seen below) until they are washed away by rain and stream.

ELEMENTAL SCULPTURING

Weather, working along joint planes, can often produce weird effects of natural sculpture. The above view of Haytor rocks, Dartmoor, shows the grotesque shapes typical of weathered granite, the rock form being determined largely by the joint planes.

MOULDED BY THE YEARS

A layer of hard rock will protect the strata beneath it from the erosive effects of weather. The photograph below, of the Winnats Pass, Derbyshire, shows how bosses of rock stand firm under this capping, depressions marking where it has been removed.

Dixon-Scott

W. D. Taylor

FANTASTIC SHAPING

The effect of natural sculpture is sometimes remarkable in its resemblance to some well-known object or person. This rock at Land's End is called "Dr. Syntax's Head" from its supposed likeness to a character in the fiction of a century ago. Water and wind, acting upon the hard and soft portions of the rock, have largely contributed to this result.

up to the peak. Splendid examples of such screes can be seen at Wastwater in the Lake District and at Mam Tor in Derbyshire.

Wind, too, now plays its part, for it can carry away the dust that has crumbled off from the rock, and thus aid in the work of disintegration. Where there are stretches of dry sand the wind may blow the sand grains across the country, wearing away rock with which they come in contact after the manner of a sand-blast, but such weathering is more typical of desert countries, and is not a common feature of the British Isles.

An even more important influence on the landscape is that of *chemical* weathering. Rain falling through the air comes into contact with a gas called carbon dioxide that is present in small quantities in the atmosphere, and forms a weak solution of carbonic acid. This acid has the power of dissolving the mineral calcium that is present in many rocks, particularly chalk and limestone. Rainwater falling in a limestone district percolates through the joints, widening them by dissolving and carrying away particles of the rock itself, making the wide cracks, gorges, and underground caves that may be seen in many limestone districts, notably in certain parts of Yorkshire and Derbyshire.

Examples of Chemical Weathering

But limestone is not the only rock that is thus affected by chemical weathering. Many formations contain calcium in some form ; igneous formations often contain minerals of a calcitic nature which are dissolved out by the weak acid solution. This phenomenon is commonly seen in granite rocks, where one of the minerals, known as *felspar*, is dissolved out by rainwater, often being deposited later in the form of *kaolin*, or china clay. The granite which is thus acted upon by chemical weathering is left in a weakened and crumbling condition, so that it is easily attacked by the forces of mechanical weathering. Again, certain sandstones have a calcareous *matrix*, or cement, that binds the grains together. When this matrix is dissolved by rainwater, the sand grains are loosened so that they are carried away easily by rills and streams. Thus chemical and mechanical weathering combine in their work of sculpturing the land.

Weathering sometimes carves the rocks into fantastic forms which appear as though they had been shaped by the hand of Man, or, as some country people believe, through the agency of some supernatural power. Granite often weathers along its joint planes so as to give a strange appearance, and locally such stones as the Cheesewring, near Liskeard, are famous as landmarks.

The joints in limestone may widen into cracks, the irregularities of which run into strange shapes, arches, and pillars, while in many sedimentary rocks which have alternate bands of hard and soft strata, the hard bands will stand out from the softer rock.

Although such freaks of landscape are comparatively rare, some signs of the weather's handiwork are visible in every part of the British Isles. Mountain tops, hillsides, cliffs, valleys, and even placid agricultural plains will yield plenty of evidence to show that the weather is ceaselessly carrying on its work of shaping our land.

STUDYING THE SCENERY

When walking in the country, examine the bare surfaces of rock wherever they are exposed, and notice the action of weather upon them. Look for the cracks or joints which traverse most rocks, and notice how weathering has taken place along these lines of weakness. Notice how, in some formations, hard bands of rock have withstood the weathering and stand out from the softer strata.

Traces of Weathering

Pick up pieces of rock from the countryside and examine them carefully. If the fragments have sharp edges, they have not long been detached from the parent rock. Loose stones that have been weathered for long are rounder in outline, with blunter edges, while those that have been carried far by rivers have a round shape and polished surface. Procure a fragment from a scree and a pebble from a river bed and compare them.

Rocks and the Landscape

As you pass through the countryside try to make out what type of rock has formed the scenery. Notice how the scenery changes. There is always a reason for this change, and it is for you to discover the why and wherefore of it. Perhaps a hard band of limestone is the cause of an escarpment being where it is ; perhaps some wild moorland may never have been cultivated because of the unfertile soil derived from the underlying rock. If you can procure a geological map of the district in which you are staying or which you visit, this will help you greatly in your task. You will then see how outcrops of the same formation in different places will lead to a similar type of scenery in those places. Notice those rocks which are water holders and those which are pervious to water. It is this different quality of clay and sandstone which makes the latter such a much healthier district in which to live. Notice how the rocks affect the water ; water in a granite country is always pure, while water from a chalk or limestone country is always "hard," owing to the quantities of calcareous matter dissolved in it.

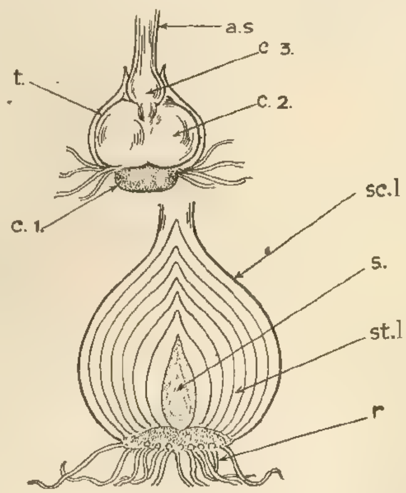
The Flowers of Our Countryside. 3

WELCOME SIGNS OF SPRING'S RETURN

SO limited is the rural experience of the great mass of town-dwellers that there will be many who will feel surprise at finding daffodils, if not snowdrops, treated in this section of our work. As will be seen, however, from the chapter that follows, both one and the other are to be found in a wild state, and their study introduces us to the subject of propagation by bulb

PERHAPS the best-known flower of the garden in springtime, the daffodil is by no means uncommon in the wild state, and is a surprise in store for the rambler who has never come across it. Beautiful as it is in the garden, in any one of the myriad varieties that have been produced by the art of the scientific bulb-grower, it has, when found wild, a naïve beauty entirely different from that of the well-ordered array of the gardener. The surprise of the daffodils, immortalized by Wordsworth as "fluttering and dancing in the breeze," is one to which no one can fail to respond, and the first sight of them, a flickering golden carpet in the open field or beneath some great old tree on the edge of a wood, is one of the never-to-be-forgotten incidents of a lifetime.

The wild daffodil is a smaller and rather daintier plant than the cultivated variety, though its inferior size is very often due to poor soil and the lack of thinning and replenishing of the stock. The leaves, narrow and smooth and of a greyish-green, appear before the flowers, and in quite early spring one may see the sharp spikes sticking up through the soil, often piercing the leaves that lie above them as they shoot up to the light.



CORM AND BULB

Top, corm: a.s., aerial shoot; c.1, c.2, c.3, corms for previous year, present year and next year respectively; t., scaly covering. Below, bulb: sc.l, scale leaves; st.l, storage leaves; s., undeveloped stem; r., rootlets.

Flowers of the Daffodil

AMONG the early leaves may be seen the upright spike, fatter and yellowish in colour, that will give us the flower. The flower itself is enclosed in a thin, brownish bract, which covers the bud in the early stages, and the whole bud is at first upright. It is only after some weeks that the bud bends over to the characteristic hanging position, when the bract is seen to be on the top side, as though for a final protection for the base of the flower.

Each flower is single, and at the time of flowering the leaves are not much taller than the flower stalks, which may be from 8 to 18 inches, according to the situation of the plant. In dryish soil beneath trees the stalks are quite short, but in the daffodil's favourite haunts, the moist, open woodlands, or the edges of damp meadows, both leaves and stalks grow to form a really lush feature of the vegetation.

In structure the flower is curious from the botanist's point of view, for corolla and calyx are fused to form a six-lobed perianth, from the centre of which there projects a funnel-like tube, the mouth of which is rather serrated. This tube is an inch or more in length, and of a more brilliant yellow than the perianth, which is pale sulphur colour. Within the tube are the six stamens and the long style, which bears a markedly three-lobed stigma. The daffodil, therefore, has both the sexes in a single flower. An ingenious explanation of the colour scheme suggests that the brilliant tube or crown attracts the day-flying insects, such as butterflies, bees and other flies, while the pale perianth shows up at night sufficiently to attract the night-flying moths.

THE root of the daffodil is of the type that is loosely termed a bulb; in common parlance, a bulb is any fleshy root which preserves a plant over the winter. To the botanist, however, there are several distinctions to be made between a true bulb and other forms of subterranean storage organs. The daffodil has a true bulb, the characteristics of which are easily seen if the bulb is cut in half straight down the middle, as in the diagram. The bulb is then seen to consist of a number of scales, which are actually very much fattened leaves, wrapped round each other. At the base is a very short root-stem, from which the rootlets run outwards and downwards, and from which all the leaves grow up. In the centre is a large bud, in which one can see all the parts that will appear above soil in the following spring. At the side, arising from the same base, there is often a second bud, which will gradually break away and form a separate plant. This form of increase is known as vegetative reproduction, so that the bulb is not a mere storage organ but also a means of increasing the number of plants. In some bulbs the outer leaves, which are always dry and scale-like, do not surround the bulb, but overlap each other in the manner of fish scales; this formation is found in the lily bulb.

Corm-growth of the Crocus

AN example of another form of root storage, known as a corm, is afforded by the crocus. The corm results from a swelling of the stem of one year, formed above the old corm from which that stem has sprung. The rootlets come from the base of the new corm, and the bases of the leaves surround it during the summer season. The young corm supplies the needs of the aerial shoots above ground, and they in their turn feed the stem which swells

Bastin

HERALDS OF SPRING

The snowdrop is perhaps the truest and most certain herald of spring, and whether it is growing wild as shown here, or in the garden, we welcome it as indicative of the conquest of winter. In this picture the delicate form of the flower, with its prettily-marked perianth and linear leaves, is well shown.

to form the corm for the following year. As the corms develop one above the other it would seem obvious that the uppermost corm would eventually be lying on the surface of the soil. This is guarded against by the production of special roots that contract and draw the old corm deeper and deeper, so that the corm that is active for any given year is always at about the same level.

A rhizome (Gr. *rhizoma*, mass of roots) is a root running horizontally beneath the surface, and specially adapted as a storage organ. A good example of this is shown by the iris, whose rhizomes may often be seen actually on the surface of a garden bed. The rhizome differs from an ordinary root in that it has scales at intervals, above each of which is a tiny bud. The end of this subterranean stem usually turns upwards to give rise to an aerial shoot, often a long way distant from the parent plant, while one of the buds carries the rhizome on underground. The rhizome may also terminate in a thickened storage organ, which will remain over the winter and give rise to a new plant in the spring. In the potato these storage organs are known as tubers.

THE derivation of the name daffodil is probably from a late Latin corruption of the Greek *asphodelos*, the name given to a plant of the lily family. This was corrupted to *affodillus*, and thence to daffodil; the plant's other most common name, Lent lily, refers obviously to the time at which the flowers normally appear. It is interesting that the original Greek name is preserved for another of our wild flowers, the bog asphodel, a plant of the rush family, while the daffodil itself is not even a member of the lily family, belonging to the *Amaryllidaceae*, an order which is, however, quite closely related to the lilies. Several other members of this family are found wild in the British Isles, the most noteworthy being another of our favourite spring flowers, the snowdrop.

There has been much argument among botanists as to whether or not the snowdrop is a native of the British Isles, but the rambler will find it scattered all over the country, chiefly in old orchards and waste places that were once the gardens of cottages. In these situations the snowdrop has not merely retained a firm hold, being perhaps the sole reminder of what was once a lovely garden, but has spread and prospered to such an extent that the ground may be carpeted in spring with the living snow of the graceful white flowers. In the counties of Hereford and Denbigh it is thought that the plant really is native, but there is no need to go so far afield to find it in what is practically a wild state.

Very early in the year the delicate green leaves first appear, to be followed quite soon by the single stem which bears the flower, and the blooms themselves are often

YELLOW TRUMPETS

The daffodil, most popular of all garden flowers in the spring, is at its best as a woodland flower when left to flourish in the wild. Smaller, neater, and more delicate than its more sophisticated cousin, the wild daffodil is none the less lovely, and preserves under all conditions the same shape and colour, as may be seen from the photograph below.

Hosking

to be found in January. The flowers are almost pure white in colour, and consist of three sepals and three petals. The former are long and spreading, while the petals are notched at the tips, where there is a tiny patch of bright green. The stems and leaves spring from a small brown bulb, the leaves being protected at first by soft green sheaths. The bulbs grow very close together, so that when one sees them in the field it seems as if there are a number of single plants each of which has a large crop of flowers. Even if we pull up a bunch, the bulbs cling closely together, and where the soil has been gradually worn away by rain the matted bulbs and roots cause the plants to stick out of the ground in little clumps.

Snowflakes of the Summertime

As the most ornamental of the early plants, and one which may scent the air even in the palest sunshine of January, we welcome the snowdrop. Its near relative, the snowflake, may be the cause of equal delight, not merely for its beauty and on account of its comparative rarity, but also for the very unexpectedness of the places where it chooses to grow. The summer snowflake, to give it its full name, is found only locally in the south of England and in Suffolk, but it appears to be truly wild and native. It chooses for its home the very edges of streams and the wettest of meadows, and in its stronghold, the banks of the river Loddon, which enters the Thames above Henley, it grows down to the water's edge, sometimes even in the water. Flowering in late spring and well into the summer, it has become known as the Loddon lily, and provides the rambler along the banks of that sluggish stream with one of the loveliest sights he will ever behold. From out of the banks of grey and brownish mud there spring sudden clumps of rich green leaves, similar in shape to those of the snowdrop or daffodil, among which are the spikes of pure white flowers, which are immediately reminiscent of the bunches of snowdrops that we have seen in the spring.


Bastin

FLORAL SNOWFLAKES

One of the rarest and most local of all our wild flowers, the summer snowflake brings to us, during the hottest time of the year, a pleasant reminder of the fresh coolness of spring. The distinguishing feature of the flowers, in which all six parts of the perianth are spotted with green, is here beautifully indicated.

Close examination of the flower will show that it differs in several important details from that of the snowdrop. There is no apparent division into sepals and petals, for all the six lobes of the perianth are of equal length, and the parts of the perianth are of identical appearance, each of them having a green patch at the tip as had the petals of the snowdrop. Furthermore, the flowers of the snowflake grow in clusters instead of singly. Mention has been made of the way in which the small bulbs of the snowdrop cling together and produce clumps of vegetation, and this is even more noticeable in the case of the snowflake, many hundreds of whose bulbs may be found woven into a completely inextricable mass. These masses are very conspicuous in winter, for the leaves appear then, although the flowers are usually not out until May. One may thus see the clumps of leaves sticking up from mudbanks which are quite covered with water. The spring snowflake, a smaller plant, is found only in a few localities in the south of England; one of our rarest plants, it bears only one or two flowers on each spike, and both flowers and leaves appear in March.

HOW TO PRESS FLOWERS. 2

To press the flowers, lay the bottom board on the table, with the length of it parallel to the edge. Spread three or four sheets of newspaper on it, then a sheet of blotting-paper. Now take the flower to be preserved, dry it carefully, and put it on the blotting-paper with the head of the flower to the left. Let the plant look natural. Place an upright plant straight on the page, with margin top and bottom. Let the head of a snowdrop or harebell droop, and a spray of wild clematis trail down, across the page. Do not untwine the lesser bindweed from a stalk of grass, but press grass as well. A tall flower, such as a yellow iris, will need to be pressed in two parts, one with flower and bud, upper stalk and leaves, and then beside it the lower leaves and root. With a bushy plant, some of the leaves should be picked off.

When the plant is placed in a roughly natural position, arrange the stems, petals and leaves with a fine paint brush, then immediately cover them with scraps of clean blotting-paper. A little piece should be put between the top and bottom petals of a flower that is pressed closed. As the work progresses press the second drying sheet down over the part done.

Treatment of Buds

When completely covered by the blotting-paper, put another four sheets of newspaper, or more for a thick plant, carefully over it, a sheet of blotting-paper on that, and continue with the next plant. Suppose an ox-eye daisy is the next. Arrange it on the drying-sheet; then cut a circular piece of blotting-paper, with a hole in the centre, and put it over the flower. A similarly shaped piece of cotton-wool goes over that, and the white florets thus get the same pressure as the golden centre. Large buds should be treated in the same way, also the fruit, or seed pods. The fruit, in all stages of ripeness, should be pressed as well as the flower.

When all the flowers have been thus arranged, cover them with the second board of the press, lift the whole on to the straps, and fasten them. Fasten one strap loosely, then the second, then tighten them. Put the press away with two or three flat-irons resting upon it.

COUNTRY COUSINS OF THE SACRED SCARAB

In ancient Egypt the dung-eating or dung beetle was regarded as sacred to the Sun-god and symbolical of the process of creation. As will be seen from what follows, we, too, have our dung beetles, just as remarkable and interesting in their ways as the insects which evoked the Egyptians' admiring awe, but regarded in a very different light

Walking in the warm evenings in spring or summer in the open or under trees, one may often be startled by a loud whirr as some big insect passes close overhead; the beetle, for such it is, may actually bump right into the walker and then fall, disconcerted and upset, to the ground. During a limited season such an encounter may result merely in the discovery that the evening flyer was a cockchafer, a beetle of which more will be written later, but it is much more likely to be one of the big, roundish, glossy blue-black insects known variously as dor, dumble-dor, or dung beetles.

One of the commonest of our beetles, the true dor beetle is one of a number of closely related species all similar in appearance and habits. These beetles are members of a sub-order known as the *Lamellicornia* (Lat. *lamella*, thin plate; *cornu*, horn) from the fact that the horns, or *antennae*, terminate in a club composed of several segments flattened in a leaf-like manner. In some members of the group this "plate" is very noticeable, but in the dor beetles it appears to the naked eye as little more than a tiny club. Under the lens, however, it may be seen to be of the formation described above. The dor beetles are the humble cousins in this country of the scarab, the sacred beetle of the ancient Egyptians, and hence the family to which they belong is known as the *Scarabaeidae*.

Ward

PREPARING TO TAKE OFF

One of the commonest of all our beetles, the dor, dumble-dor or dung beetle, as it is variously called, is a familiar object during spring and summer. In the above picture we see it climbing laboriously up through the grassy jungle until it can reach a point of vantage from which to take off on its clumsy, whirring flight.

All the common species of dor beetles found in the British Isles are of the same blue-black or violet-black colouring.

The differences between them are not very great, and from their general similarity of habit they count as one type to all but the specialist in *Coleoptera*, with the possible exception of one, sometimes known as the lunar dung beetle, which will be described in detail later. Dung beetles are often found to be covered beneath with what at first look like a number of little reddish brown spots. These spots are seen to move about and they are in actual fact mites of a species that lives exclusively on large beetles of this type. The exact relationship between mite and beetle is one of the unsolved mysteries of Nature. It is not known whether the mite actually harms the beetle or whether it simply attaches itself to it in the hope of being taken about from dunghill to dunghill so that it can get a free ride between meals! On account of these mites the beetle is sometimes known also as the Lousy Watchman.

Burrowers in Dungy Mounds

The larger dung beetles of the type described above may often be seen at work. If possible, let us pursue one as it flies past, and watch it until it settles; although they fly more in the evening they may not infrequently be seen on the wing in daylight. The insect will be seen to settle on or near a mass of cow dung or horse dung in a field, and almost at once starts burrowing. In the burrows made, eggs are laid by the fertilized females; the young larvae feed on the dung, and may, in fact, often be found *in situ* in various stages of development.

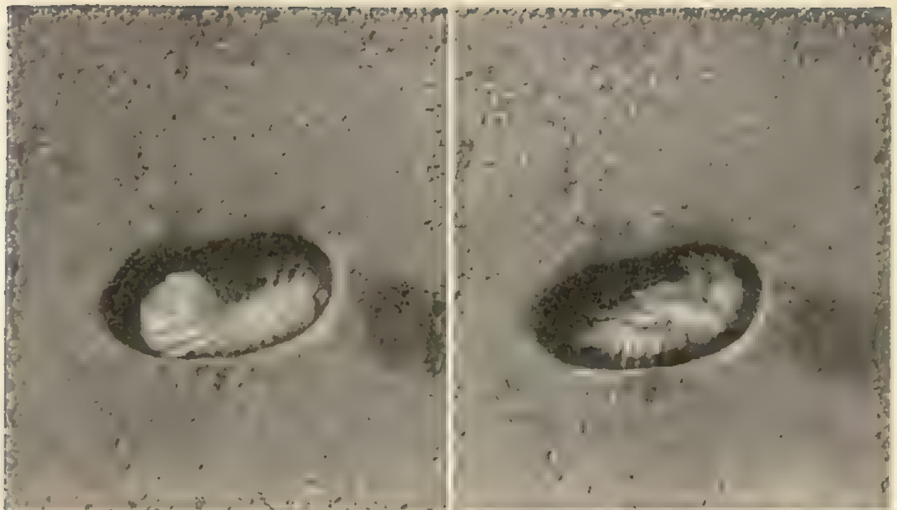
In dry, warm and sandy places the observant naturalist may sometimes come upon a smaller beetle that bears a superficial resemblance to the common dor beetle; this is the female of the lunar dung beetle. She is about half an inch in length, whereas the larger cousin may be as much as a full inch. The male of the lunar dung beetle may easily be recognized by the fact that on the thorax, the middle part of the body, he has three horns that project forwards, the two at the sides being considerably longer than the one in the centre. Many of the foreign cousins of this beetle are very large and are armed with enormous horns of a similar nature, but for his armament and his ferocious appearance he is almost unique in this country; the stag beetle, a far better-known species, has his horns developed in a completely different manner.

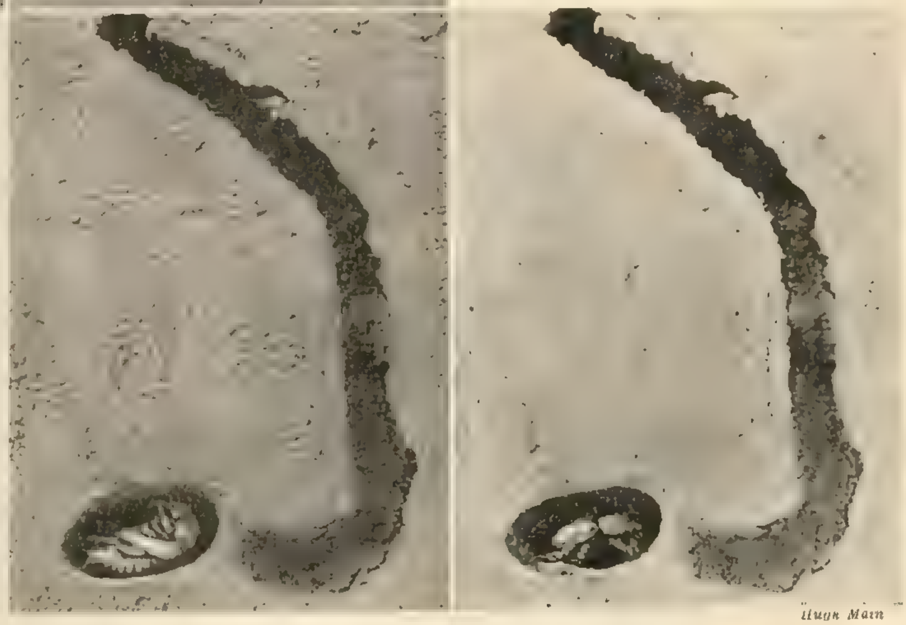
When spring comes, the lunar dung beetle emerges from the snug hole in the soil in which he has lived

throughout the winter and sets out to sate the appetite he has acquired after some five or six months underground. This he does by feeding until replete on sheep or rabbit dung, after which he goes in search of a mate. The female, having perhaps emerged a little earlier, sets to work at once on the business of digging a more or less vertical shaft into the soft sandy soil which these beetles frequent, and to her aid the male beetle swiftly flies.

If it chance that two males arrive at more or less the same time in competition for the favours of one female they will set to and have a little mock battle, butting at each other with their heavy horns, but not sustaining any damage. The female then accepts one of them, and the disappointed suitor flies or crawls quietly away.

The mystery of how this little trident-bearer digs his subterranean home and stocks his larder was solved to a large extent by the famous French naturalist, Henri Fabre. As a result of his observations and those of later workers in the same field we can present a complete picture of the history of the undertaking. The female, as has been said, mines the shaft, starting long before the male puts in an appearance, and it is the latter's business to remove to the surface the soil that the female has disturbed. After a time his work changes, and he sets out for the nearest heap of pellets of rabbit or sheep dung, which he proceeds to roll with infinite patience to the mouth of the shaft. There the pellets are broken up and dropped piecemeal to the female, who has made a little chamber off the side of the main shaft. She in her turn kneads the broken fragments into a roughly sausage-shaped pellet, which is placed in the chamber; an egg is then laid in the sandy floor near the new pellet. The tunnel goes on down, with chambers at the sides, filled with their pellets and the egg laid ready in each one, until it may reach a depth of as much as six feet.





Hugh Main

SUBTERRANEAN TRANSFORMATION

At the base of its burrow, many inches beneath the surface of the soil, the grub of the lunar dung beetle, *Geotrupes typhaeus*, changes from larva to pupa and then to adult insect. In the series of photographs in this page we see a female larva undergoing the transformation. Top left, the fully grown grub. Next, the larva has just undergone the change into a pupa or chrysalis. Bottom left, the pupa, now nearly an adult insect, still reposes on its back, but as soon as it has become a complete adult (bottom right) it turns over to a more comfortable position facing the entrance of the pupal chamber. (Top photos, × 1½; bottom, life-size).

Few cases are recorded in the insect world in which the male takes even so much interest in his progeny as to help provide the food, but the dung beetle is exhausted by his efforts and when the last pellet has been dropped down the shaft he creeps away into the sunshine to die. It is for this reason that, about the end of May and through June, one may find numbers of the dead male beetles without ever seeing either male or female alive. The female herself is not very much longer-lived, for when her last egg is laid and all the pellets have been remade inside the shaft, she, too, dies. The sole function of the insect's life, therefore, is the reproduction of its own species.

When each grub hatches—which happens a month or less after the laying of the eggs—it creeps into the pellet in its cell and starts to feed; each pellet contains exactly the right amount of nourishment for the life of a single grub. The grubs themselves are of a dead white colour, with brown heads, the rear part of the body being greatly enlarged and full of the waste products of digestion; this mass of waste matter is held throughout the grub's active life, and then, when the pellet is all gone and the

time comes to turn into a pupa, the grub excretes the waste and lines the chamber with it. In the stiff-walled room that results the grub changes into a pupa or chrysalis, and then, after about a month, into an adult insect. Before the year is out this new adult bores his or her way through, it may be, as much as six feet of soil to the surface. There a feast is made of the dung of rabbit, sheep, or even larger animals, and then a shallow shaft is dug in which the insect spends the cold winter months. This hibernating shaft, however, is first lined with dung, collected in the form of pellets and ground up to form a warm and waterproof wall to the chamber. From the bottom of the shaft the insect works its way up when the warm days of early spring come round again.

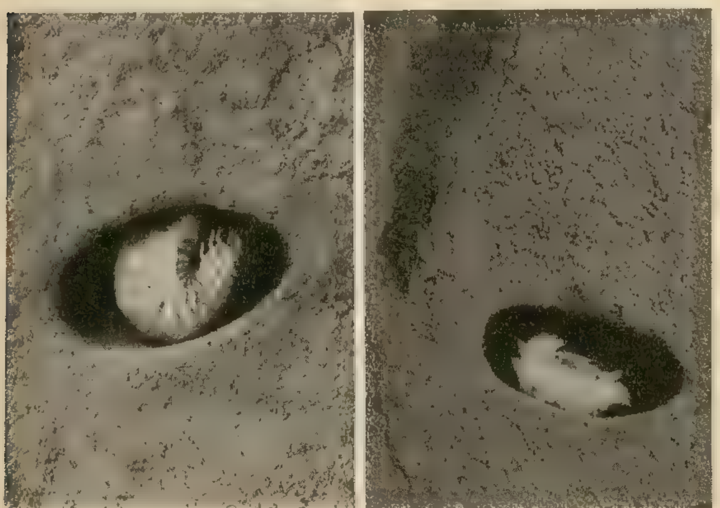
Bustin

HORRIFIC BUT HARMLESS

This dangerous-looking monster is the male of the lunar dung beetle, enlarged some three-and-a-half times. His armament of horns, composed of outgrowths from the thorax, is used in his battles with rival males. Notice the strong legs, especially adapted for digging, and the heavy plating of the thorax

NUMEROUS theories have been put forward as to the use to which the trident is put by the male insect. Fabre considered that it was used in the same way as a builder's hod to assist the insect in pushing the earth to the surface of its burrows, and there is no doubt that the horns do enable it to increase its capacity considerably. At the same time, it must be admitted that there are other beetles which, though devoid of horns, seem capable of removing as much or more material from similar shafts with no more trouble than the horn-bearer. It must be noted that the digging of the main shaft, however deep it may be, is apparently performed solely by the female beetle, which may dig down as much as seventy-five times its own length.

There are many other beetles that can be found in association with cow and horse dung; some of these are remarkable for the width of their wing-spread, which may be twice the length of the insect's body. Few of our English beetles, however, have been given English names, for only the expert entomologists have shown much interest in them. One of the most interesting of the common species is the pill beetle, a member of a different group from the *Scarabaeidae*. This rounded beetle, well deserving its popular name, looks almost exactly like a pellet of rabbit dung, and it is, in fact, on rabbit dung that it feeds. Found often creeping among moss, and deep in the grass, it feigns death when touched or approached, and is then almost impossible to distinguish from its foodstuff, thus providing us with yet another obvious example of what is known as "protective resemblance."



Hugh Main

GRUB AND PUPA

Left, grub of a male lunar dung beetle (× 1½); it is bulky with food, and lies in an apparently uncomfortable position on its back. The lining of the chamber, composed of excreta long contained in the grub's stomach, is easily visible. Right, the grub (life-size), metamorphosed into a soft, white, and as yet not fully-formed pupa.

HOW TO COLLECT BEETLES

The collecting of beetles is not a hobby to be lightly undertaken, but at the same time it is almost inevitable if they are the object of any very special interest. There are upwards of 4,000 British species, and many of these are so small that only close search will provide specimens for the collection, but, at the same time, there are so many relatively common species that it is impossible to become acquainted with their classification and habits without first identifying them and keeping a few specimens for reference.

Killing the Spoil

One of the first snags that the beginner is likely to encounter is that most beetles are remarkably hard to kill. The cyanide killing bottle that may suffice for butterflies and moths and other insects is of little use, for it makes death a slow process and, if there are any other insects in the bottle, the beetles will as likely as not crawl over them and spoil them, and may even make a meal of them! Crushed laurel leaves are often recommended for the killing of beetles, but they must be frequently renewed and are troublesome to prepare; dropping the insects into boiling water is a quick method, but they are likely to be extremely stiff when it comes to setting them up. The best way is to get from some chemical suppliers a bottle of the liquid known as acetic ether. If a little of this liquid, which is a powerful anaesthetic with a sweetish and not unpleasant smell, is soaked up in cotton-wool in the bottom of a screw-topped bottle, we have an admirable killing bottle for all kinds of insects.

Setting beetles is another point of difficulty. They are for the most part too tough to be stuck through with a pin, although the larger ones are best treated that way, the convention with all collectors being to pin them through the right *elytron* or wing-case.

Setting Beetles

The recognized method is to set them out on a slip of white card, using for the purpose gum tragacanth, obtainable at the chemist's in the form of a whitish powder. When mixed with a little water it makes a very strong and invisible gum. Legs, antennae, and mouth-parts if they project, may be set out. The date and place of capture should be written on the under side of the card, and the card pinned into a proper collecting case, lined with cardboard

LOVE AND WAR AMONG THE TROUT

ALL the fish to be found in the rivers and lakes of the British Isles will be described and pictured under the heading of "Our Freshwater Fishes," and for convenience of arrangement it also covers such fish as salmon and eels, which either breed or live their mature lives in inland waters. The life stories of our principal fishes are little known, even to those who spend long and peaceful hours on anglers' stools, and there will be much that seems strange in the account of the trout given below

THOUGH a subject of especial interest to the angler, the study of freshwater fishes offers fascination to both the scientific observer and the rambler. Once some idea of their life-history and habits has been gained, the rambler may find ever-increasing joy in the observation of the life of the rivers and streams of the countryside. The trout is the most interesting of all freshwater fishes. Apart from the numerous problems of natural history which it offers to the scientist, the very name of the fish brings recollections and visions of silver streams and quiet green pools, of the never-ceasing chatter of mountain waters and the loveliness of rippled lochs and quiet meadowlands.

Trout are to be found in many different habitats, ranging from the oily weir-pools of the stately Thames to the tiny, babbling streams of the heathery moorlands. They occur also in the brackish waters of the river estuaries around our seashores, and, together with the salmon—trout and salmon are members of the same family, the *Salmonidae*—some species live permanently in the waters of the ocean and only ascend the freshwater rivers to spawn.

The life history of the brown trout (*Salmo trutta*) is extraordinarily interesting. In the autumn the fully developed male becomes restive and dissatisfied with his life in the lower waters of the river, and through the natural urge to reproduce the species he seeks about him for a mate, who will travel up the river to the spawning grounds, situated always near the head of the stream This search may take a little time, especially if the river is very crowded with other males all equally intent upon the quest for a bride.

IF two males set their hearts upon the same female, a fight will almost certainly ensue between these two beautifully coloured fish, and neither will give way until honour has been satisfied. A fight between two fish of the same species is an altogether uncommon sight, even for the most experienced of naturalists, and anyone who has seen such a thing can consider himself extremely lucky. Making a series of dives, the two trout eventually become locked together when one or the other of them gets a strong hold with his powerful mouth on the other's lower jaw, or is held in a firm grip over his own upper jaw and snout. When they are once locked together in this strange manner, a battle royal of swishing and swirling ensues. Over and over they turn, now in a flash of silver as their bellies come uppermost, now in a jumble of dark brown backs almost indistinguishable amid the churned-up mud and weed. The fight may last for several minutes before the stronger of the two fish eventually

SPOTS OF FEAR

When in the presence of acutely-realized danger, trout assume a blotchy appearance, matching so closely the stony bottom of the stream or pool that they are invisible to all but the most experienced watcher. The trout in the left-hand photograph has assumed this protective camouflage; on the right is seen its normal appearance.

gains on his opponent, and, shaking him as a dog shakes a rat, beats him into unconsciousness against the stones of the river bed.

The trout who has received this *coup de grâce* turns slowly over on his back, and, as is the way with all fish when they lose consciousness, his air bladders deflate and he floats gently to the surface. By the time he has recovered and, turning slowly over, swum down to some quiet, dark hiding place beneath the bank, the victor will have gone on his way, no doubt in the company of the female fish—his reward for victory. The river cannot be ascended unless in flood, for, when only the normal amount of water is flowing, there are always long stretches of shallows and a large number of thin, trickling waterfalls, up which even a very ardent and athletic trout and his bride cannot jump. On the journey upstream there may often be delays of whole weeks, when the rains fail the adventuresome couple, and they are then forced to lie up in some deep pool and wait for the coming of the floods.

Upstream Against the Torrent

With the arrival of winter, the rain falls on the hills and the waters of the river become thick with the mud and débris washed into the gorge; it is not long before the pools are lost in the raging torrent, and the waterfalls no longer trickle but roar as the turbid waters pound the now hidden rocks of the river bed. It is then that the pair of trout lurking in the deeper pools are again able to continue their journey. Struggling onward, fighting against the torrent, and keeping always close into the bank, where the force of the current is at its lowest, the male trout leads the female upstream towards the spawning grounds.

Evidence of the trout's wonderful powers of climbing streams is to be found in the shallow pools and tiny brooks, often many thousands of feet above sea level, where if a stone be lifted a trout will almost certainly be seen.

SAFE AND AT EASE

Here are two fine, full-grown trout, lying on the brook bottom in the shelter of a large rock, safely hidden from their natural enemies on the bank. Facing upstream, with their mouths opened to allow the passage of the oxygen-bearing water through their gills, we may be sure that they will quickly rise to the surface if a ripple should reveal the presence of an unwary fly. (One-third life-size).

Berridge

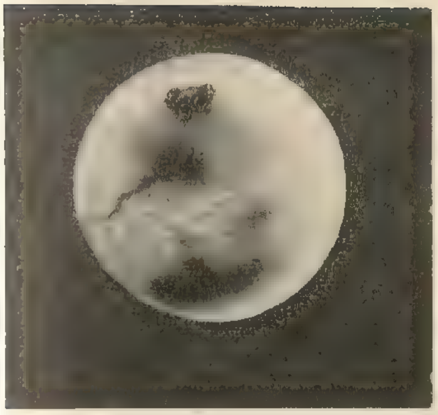
Trout of all sizes are to be found in the loneliest of places, sometimes above waterfalls more than twenty feet in height, and the only explanation of their presence is that they jumped the waterfall when the river was in flood. Such trout as these are often so small and stunted that one is led to believe that they are not fully-grown and that only young ones are to be found at such heights; but this is not so. In the cold and scanty waters of the high moorlands and mountain passes there is extremely little for the young growing trout to feed on, and it is for this reason that they remain small, and are often to some extent distorted, with bulging eyes, and thin scraggy bodies.

When the female trout at last reaches the spawning ground of her choice, after a little persuasion from the male she selects a spot behind a boulder out of the flow of the current, and, lying flat on the bottom, by means of a swirling movement of her tail makes for herself a small pocket-like hole in the sediment and shingle. In this hole, or "redd" as it is called, she deposits her hard roe in the form of spawn; then, moving a little out of the way, she allows the male to come into position and to secrete his soft roe or "milt," from which the spermatozoa originate and fertilize the spawn. The female with a movement of her tail changes her position to one a few inches farther on, and, by excavating another redd, covers over the last one, thus protecting the eggs from all harm. In this second redd she deposits another collection of her eggs, which are at once fertilized by the male fish and in the same manner covered up and hidden.

In this way, with intervals for rest, the female trout continues to spawn for three days. A large trout may lose as much as a pound and a half in weight before she has finished, burying perhaps fifteen hundred eggs in a series of redds over a large area.

The duty of the parents is now over, and after a few days they drop downstream to spend the winter feeding on small freshwater shrimps and shellfish, until by the next spring they are the same firm-bodied trout that they were the summer before.

In the meantime the eggs have begun a wonderful process of development. This was for many years one of the mysteries of the natural sciences, and it was only after long and difficult research that the complete life history of the trout was worked out. The waters of the sparkling stream, saturated with oxygen absorbed in the tumbling of the waters through the air on their way down the faces of the numerous waterfalls and steep gullies, make their way in little eddies around the eggs buried under the shingle and sediment. In less than six weeks two tiny black spots appear on the membrane of each fertilized egg. These show the beginning of the development of the eyes, always the first of the organs to be developed in incubation. It is only another six weeks before the young are ready to hatch, when, struggling and wriggling, they force themselves free of the membrane, and, splitting it from end to



TROUT DEVELOPMENT: THE FIRST STAGES

(Left). Six weeks after the trout egg has been fertilized, two black spots appear under the enclosing membrane; these are the eyes to be. (Right). During the process of hatching, which takes place after the twelfth week, the head is thrust through the membrane, while the heart can be seen as a dark spot with blood vessels on either side. Just after fertilization, the trout egg is about a tenth of an inch in diameter

end, find head, tail and all for the first time in the fresh waters of the mountain burn.

At this stage, when they are first hatched, the trout are known as "alevin." They do not look much like their parents, but have enormous heads, small stumpy bodies and fine delicate tails. They are made to look even more clumsy by the presence of the huge yolk-sac, the natural feeding-bottle, which keeps them alive as free-swimming fish in the water for the first six weeks of their lives.

ALMOST LIBERATED

Following the head, the yolk-sac is forced out; here we see it half-emerged, nipped in the middle by the membrane. The pectoral fins now come into action.

Exhausted with its exertions of hatching out from the membranes of the egg, the little alevin lies panting on its side, but is soon sufficiently revived by the fresh waters and the large amount of dissolved oxygen therein, to burrow its way deep into the soft pile of sediment behind a large stone in order to get away from the light, for which it has a great aversion. Here, lying under a small pile of tiny stones, the little fish keeps itself well supplied with oxygen by a quick movement of its minute pectoral fins, which cause a current of water to flow round the gills.

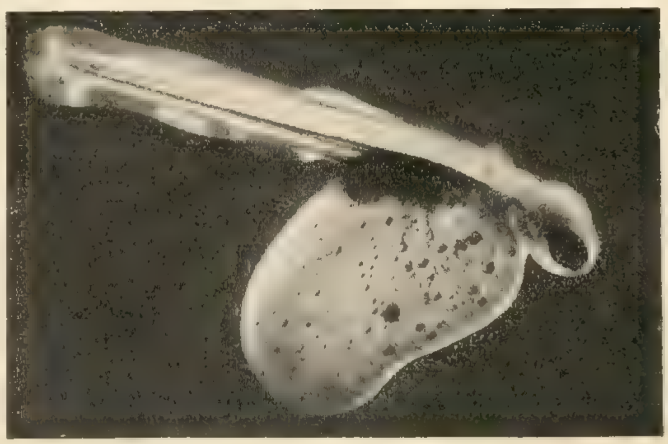
It is an interesting fact that only a very small proportion of all the eggs deposited by the females and fertilized by the male trout are actually hatched out after the required period. Many accidents may befall them, and sometimes the eggs are insufficiently covered with gravel and are washed out of the redds, to be quickly eaten by the young trout, who are always on the look-out for this cannibalistic form of food.

At the age of five weeks the yolk-sac becomes almost absorbed, and the young fish leaves the little home it has made for itself in the gravel, and starts off downstream for the feeding grounds of the older trout. In the daytime he swims about and begins to feed on minute organisms, which he sucks into his mouth and swallows together with a large quantity of water. At night he still seeks the shelter of some friendly stone, and remains hidden from his natural enemies of the river until morning. It is at this stage that the sticklebacks and various other young fish begin to take their toll of the young trout, while caddis worms and larvae of all kinds, crawling eagerly after them into their shelters, still further diminish their numbers.

Seven or eight weeks after the alevin bursts through the membranes of the egg the yolk-sac completely disappears, and the tiny fishes are then known as "fry." At this stage the young fish enlarges his diet, and water shrimps, larvae, and the previously dreaded caddis worm become part of his menu. During the whole of the next year he continues to grow, and, if he evades all his numerous foes, by the following spring he is from four to eight inches long and is known as a "yearling."

For still another year he remains, as it were, in an adolescent stage, during which he reaches a length of from six to twelve inches. It is in the autumn after this that he ascends the river in the same way as his parents did, and, selecting a mate, waits for the floods and finds his way to the spawning grounds.

Apart from the fascination of its life history the trout has presented many other interesting problems to the



ONE WITH ITS LARDER

Now completely free from the egg, the baby trout starts out in life carrying the large yolk-sac on which it depends for food during its first five or six weeks until capable of hunting minute infusoria for itself. The eyes are large and the body undeveloped.

naturalist. It has been for many years a question of great doubt whether so many different types of trout exist as was formerly believed. Dr. Tate Regan, perhaps the greatest living authority on fish of all kinds, believes that nearly all the numerous species, such as the Irish "gillaroo," the brown trout, the pollan, the brook trout, and even the sea trout, are exactly the same, except that, through the effect of difference in environment and in available food, they take on a distinct colouring and appearance.

AWKWARD ADOLESCENCE

At the age of about five weeks, the young trout, or alevin, having absorbed nearly all the nourishment from the natural feeding-bottle, or yolk-sac, leaves the place of his birth to go forth and explore the more distant waters of other streams and start his life as a free-living fish in the true sense of the word.

Glittering Scales

It has long been known that a diet of shellfish brings about that brown coloration typical of the brown trout and others of mountain stream habitats. After some research it was also discovered that the silvery appearance of the sea trout and true salmon is due to a substance known as "guanin," which gives rise to the formation of "iridocytes" (Gr. *iris*, *iridos*, rainbow; *kytos*, hollow vessel, cell) in the scales. Guanin is formed from the shells and hard outer covering of minute crustaceans, and is thus present on the scales only when a diet of a large number of the organisms can be obtained. Such a diet is, of course, most easily obtainable when the trout are in the sea, where the shrimps and other crustaceans are to be found in thousands, and for this reason the sea trout are silvery in appearance. This silvering of the body of salt-water fish is also of great use to them as a protective measure, for since it acts as a mirror when viewed by other fish from the side, it makes the silvered fish almost invisible, and thus more easily able to avoid their foes.

A further interesting fact about the colouring of the trout is the way in which, if it is at all frightened, the pigment cells underlying the scales on the back and side contract suddenly in certain areas and remain relaxed in others, thus giving the fish the blotchy appearance necessary for concealment. As soon as the cause for fear has passed the colouring again returns to the normal, the blotchy patches disappearing as quickly as they came.

Revealers of Nature. 3

IZAAK WALTON

It is not often that a City business man, least of all one engaged in the very unromantic trade of ironmongery, opens the eyes of a nation to the beauties of Nature in a little book that will slip into a rambler's pocket and today is one of our prose classics. Izaak Walton was a successful tradesman at his shop in Fleet Street, near the corner of Chancery Lane, and before he published his chief work at the age of sixty had made a name for himself as the author of biographies of John Donne, whose parishioner he was, and of Sir Henry Wotton, a man of great learning and his close friend. These Lives were followed by three others, noted for their matter as well as for their style; yet it is not for these works that Walton's name is generally revered, but for that slight volume on "rivers, fish-ponds, fish and fishing"—"The Compleat Angler, or The Contemplative Man's Recreation."

Let not non-anglers be deterred from reading this book; technical detail concerning bait, casting, flies and so forth is not lacking, it is true, but gentle Izaak had others than anglers in mind when he wrote. "In writing of it," he says in his preface, "I have made myself a recreation of a recreation, and that it might prove so to the reader, and not read dull or tediously, I have in several places mixed (not any scurrility, but) some innocent, harmless mirth"; and again, "the whole Discourse is, or rather was, a picture of my own disposition, especially in such days and times as I have laid aside business and gone a-fishing." Anyone who will lay aside his business and go a-fishing with Walton will find more than recreation; he will have made a friend for life.

Walton lived through one of the most stirring periods of English history. Born at Stafford on August 9, 1593, in Elizabeth's reign, he endured the Civil War and Commonwealth with great patience, though an ardent Royalist and a strong Churchman, connected with the families of Cranmer and Ken by his two marriages. He lived in Clerkenwell until about 1662, probably doing much of his angling in the New River, but thereafter passed most of his life in the country, finding homes at the houses of various country clergymen. He died at the house of his son-in-law, a prebendary of Winchester, on Dec. 15, 1683.

"The Compleat Angler" came out first in 1653. It is in the form of a series of dialogues—between Piscator (the fisherman), Venator (the hunter), and Auceps (the bird-catcher), to whom Viator (the traveller, or "hiker") was added by Charles Cotton, Walton's dearest friend, who wrote the second part of the book, added to its 5th edition in 1676. But no bald description can do justice to the May-morning freshness of this little book, which derives alike from Walton's exquisite prose style and from his honest nature. "We anglers all love one another," he says, and this statement is indeed comprehensible if all anglers possess his happy temperament.

But apart from Walton's own character and his style, or because of them, the book has a universal interest. As a certain Charles Harvie, who contributed a commendatory poem to the book, writes:

> The world the river is; both you and I
> And all mankind, are either fish or fry;

and he who has made the close acquaintance of Izaak Walton has learned how to become not only the "compleat angler," but also the "compleat gentleman."

BROCK THE BADGER IN HIS SOLITARY SETT

BADGERS are among the larger of Britain's present-day wild carnivora, but their nocturnal and solitary ways remove them from general observation. Many interesting facts concerning these harmless and inoffensive denizens of our woods and hill country are given below, and further pictures will be found in page 116

ALTHOUGH they are generally considered to be among the rarest of our wild animals, there are probably just as many badgers hiding in the woods and on the common-lands of England today as there were two hundred years ago. Seeing is believing, and when we see the deer in Richmond Park and the wild species on the hills of Scotland, it is easy enough to believe that there are more of these animals about than we actually come in contact with. Every country rambler sees rabbits and hares, birds of all descriptions, and perhaps even an otter or two, but there are very few indeed who have actually seen a wild badger.

Brock, to give him one of his old names, is chiefly nocturnal in his habits and only comes out in the daylight if driven from his underground hiding-place by some enemy able to dig for him. In the olden days digging for badgers was considered a sport, and the complicated burrows which these animals make for themselves were given the sporting names of "setts" or "earths." A badger's earth may consist of a multitude of tunnels and galleries running perhaps a matter of sixty or seventy yards under the ground and, if the soil is soft enough, to a depth well over ten feet. There is usually one entrance to this hiding-place, though sometimes a secondary back door may be found many yards away, carefully hidden under the branches of some low shrub. No trouble, however, is taken by Brock to hide his front door during the summer months, when he makes nightly use of it for going forth on his expeditions in search of food. It is usually a wide-mouthed hole situated in the side of a dry mound close to the roots of several large trees. The badger has an inherent dislike for dampness, and he is, therefore, found only where he can make a home which is perfectly dry and protected from the rain.

Tracks Through the Woodland

AROUND the mouth of the broad hole leading into the sett may be seen numerous radiating paths running in different directions, which are well tramped down by the feet of the badgers. If one of these paths is followed the track will be found to become fainter and fainter as its distance from the hole increases, until eventually it is lost in the undisturbed undergrowth of the wood. One of the paths usually leads to the "playground" of the young badgers, which is to be found situated some fifteen to twenty yards away, and consists of an arena-like space cleared on the ground and hidden from view by the

IN THE LIMELIGHT

Badgers very rarely come out of their "earths" during the daytime, yet this interesting photograph shows Brock coming from his burrow with his eyes averted to shelter them from the glare. His colouring, although useful as a protective camouflage at night, makes him somewhat conspicuous during the day. Realizing this, he takes care never to stray far from his "sett"

Reid

A. Brook

UP FOR AN AIRING

As soon as night falls, the male badger leads the family out of the "earth," the young ones following close upon his tail. Then, while the female stays to look after her cubs, the male goes off into the woods to seek for food and perhaps a bundle of fresh bedding.

branches of a shrub. Here the young badgers go to play and are protected from harm by the careful parents.

The digging up of badger setts has revealed that the tunnels run in a semicircular form radiating from a point some few yards from the mouth of the original hole. Every few yards along each of these semicircular tunnels secondary burrows strike down into the ground, until another level is reached and a second series of galleries made. Below this second series even a third, and perhaps a fourth if the earth is soft enough, have been discovered, the total length of tunnelling in a single sett sometimes amounting to many hundreds of yards. In Co. Wexford, Ireland, it is stated that one straight tunnel in a badger sett was found to be in itself over a hundred yards in length, and there were many of these tunnels running one below the other. In this same large sett many years ago all the badgers were exterminated by the gamekeepers of the estate, who believed that the animals were interfering with the nesting birds; but within a very few years the burrows were again occupied.

BROCK AT CLOSE QUARTERS

This picture, taken in daylight, gives a close-up impression of Brock nosing his way out of his hole. The black and white markings on the face are clearly shown, while the long-clawed and spade-shaped fore-feet are also very noticeable.

Neuman

Items in the Badger's Menu

GAMEKEEPERS have, in fact, for many years claimed Brock as one of their rightful victims, but it is extremely unlikely that badgers can do any harm to preserved game. Although practically omnivorous, Brock is completely incapable of climbing, and the only birds which enter into his menu are those which fall as babies from the nest and would have died anyway from starvation on the ground. Any garden situated near a badger sett may be difficult to keep well stocked in bulbs, for these are included among Brock's favourite delicacies, the bulbs of bluebells in their wild state forming quite a considerable part of his diet. Slugs, worms, snails, snakes, mice, as well as roots of all kinds—practically everything small enough or slow enough is made a part of the badger's diet.

During the summer months the badger repairs and generally fits out his sett for the coming of winter. He goes to great trouble to collect bundles of moss and dry bracken, which are dragged into the hole and used as a lining of the inner galleries. So as not to draw undue attention to his home he does not harvest his bedding near the mouth of his burrow, but goes off into the woods along one of the radiating paths in search of a glade where the moss and bracken may be collected in safety.

A CLEARING in the woods which has thus been made use of by badgers looks exactly as if a herd of pigs had been turned out there by the farmer. Sometimes quite a number of families will live together in the same sett; and where by accident or enemy activity the colony has become depleted, foxes and rabbits have been known to take up residence in one or other of the deserted galleries.

With the coming of winter fresh stores of bedding are dragged in, together with large quantities of decaying

leaves, the damp heat of which provides the inmates with a natural central-heating system through the cold months. With the first frost the entire colony vanish underground, and much trouble is taken to " stop " the opening, so that during the winter a badger hole may be discovered ending in a blank wall of earth some three feet under the ground.

A. R. Thompson

HALLO EVERYBODY!

This full-grown badger has been caught by the vigilant photographer immediately after leaving his "sett," and so sudden has been his emergence that straw from his bedding still clings obstinately to his snout. It is the badger's custom to come out for food only after ascertaining that the coast is clear, but this time patience on the part of the photographer has had its well-merited and long sought reward.

Brock the Monogamist

In spring this wall is scratched away and the badgers come sniffing up into the evening air for their first taste of another season in the open. Without accidents Brock pairs for life, and the mating season begins as soon as the hole has been blocked up, the young cubs appearing perhaps seven months later with the coming of March. Before this happens, however, a complete spring-cleaning has to be carried out, and all the old bedding is carefully removed and hidden away in the woods.

Badgers when newly born are a silver grey; they quickly change to a brownish yellow and finally to a blue-grey with the typical black and white stripe on the cheeks, before they are allowed by the mother to crawl out of their hole into the open. The fur of the full-grown adult, when viewed at a distance, gives the impression of a general blue-grey, but when seen at close quarters this is found to be made up of a large number of small, almost brownish-yellow spots interspersed with grey hairs. The face is black and white and the underside of the animal is almost entirely black. This coloration harmonizes very well with the half-tone lighting of the wood in the late evening, and the strong contrast in black and white on the face makes the badger particularly difficult to see in bright moonlight.

ALTHOUGH the young ones' first experience of life is confined to their existence in the burrow and in the nearby playground, their mother quickly takes them in hand and instructs them in the art of hunting for themselves and of grubbing for roots. She teaches them also to sharpen their claws against the boles of trees and to rub themselves in order to keep their fur clean. A feature of a badger hole is the presence of claw marks on the barks of the trees near by, and a tell-tale black or grey hair may often also be found clinging to a twig. The mother is careful to teach her cubs the laws of hygiene laid down by badger etiquette, and all refuse is disposed of at some distance from the sett.

The badger measures usually from 2½ ft. to 3 ft. in length and stands as much as 1 ft. high at the shoulder. The body is stout and broad, the head and mouth being

ALL QUIET?

A flashlight photograph taken at night-time in the Welsh mountains, this picture shows the wary badger carefully analysing the various scents of the night-air before embarking upon a search above ground for food and fresh bedding. Note the broad, wedge-shaped body and the small head.

A. Brook

THE BADGER'S FRONT DOOR

This entrance to a badger's "sett" gives a good idea of the size of the hole, and the way in which the tunnel enters the ground. Started usually in the side of a bank, it runs horizontally for a few yards before the numerous galleries and side branches strike off in all directions and at different levels.

very pointed and well adapted for burrowing into the ground. The ears are short and lie back sleekly on the fur, while the tail is from 7 in. to 8 in. long. The feet, which are bare on the soles, are provided with sharp claws, those of the fore feet being somewhat longer than those of the hind pair. The weight of a full-grown badger may be anything up to 40 lb., though in districts where it is difficult for these animals to obtain food an average weight of a much lower figure may be found. The dental formula (*see* page 77) for the badger is:

$$i\,\frac{3}{3},\ c\,\frac{1}{1},\ pm\,\frac{4}{4},\ m\,\frac{1}{2}=38$$

The first pre-molar is particularly small and is frequently shed at an early age; hence it is frequently found missing in adult skulls.

In his classification of animals, Linnaeus put the badgers along with the bears, to which they are extraordinarily similar, not only in their slow, lumbering walk, but in their omnivorous habits and taste for sweet things such as wild honey. Later physiological investigation has shown, however, that badgers are really quite closely connected with the stoats and weasels, in spite of their lack of activity and their nocturnal ways. The badger, like the weasel, is extraordinarily quick-witted, and cases have been recorded of badgers rolling on spring traps in order to set them off and so be able to steal the bait.

Like the beaver, now extinct in Britain in its wild state, the badger is responsible for many of our place-names. Known as Brock, Bawsen, or Grey, it must at some time or other have been a very common animal, and it has left the indelible mark of its prevalence in the names of such places as Brockham, Brockenhurst, Brockley and Brockholes, as well as Greytown and Bawsen's End. There are still large numbers of badgers in Britain today, to be found in any locality that is dry enough and sufficiently secluded. The rambler who goes through the countryside in daytime may not see them, but Brock is there all the year round, and if a good deal of trouble is taken and a careful "hide" made, he may be seen on a moonlight night coming out of his burrow, sniffing the air in search of an enemy, and then, if all is clear, bringing the children up into the open for a gambol on the playground.

How to Watch Badgers

The badger has undoubtedly the keenest wits of all the animals making up the great families of the woodlands. His senses of smell, hearing and sight are all perfectly suited to his mode of life and are soon made use of in discovering any form of threatened danger. To go badger-watching at night requires a great deal of patience, and one must be prepared to withstand a considerable amount of discomfort. It is best to arrive at the badger's "sett" well before dusk, and to select one's hiding-place in the daylight in order to make doubly sure that it is a good one. Any sort of "skyline" should be avoided; e.g. so to hide that you have to put your head round a tree to see anything of the mouth of the "sett" is a mistake, since the badger will be able to observe quite easily the change in the shape of the tree. What should be done in this case is either to stand in front of the tree or to climb up into the branches above.

Immobility Essential

The first thing to be learnt is the art of keeping perfectly still. Above everything, you must not move if the badger is actually out of its hole. The slightest noise will disturb it, and once frightened, there is no hope of it coming out again the same night.

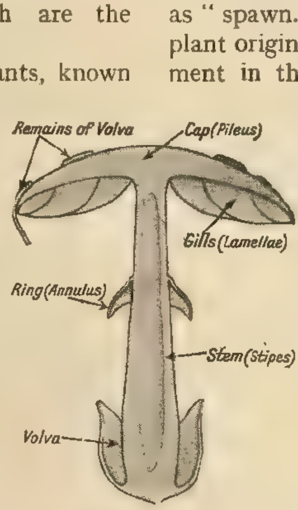
After waiting, therefore, perhaps an hour or so before dusk, a sudden noise from the direction of the hole may give warning of Brock's approach. If you are on the lee side so that the wind is blowing from the badger towards you, you will see him come out of his hole and sniff the air for any scent of an enemy. One difficulty which may be experienced is that although you may have selected your hiding-place downwind from the hole when you arrived some hours before, by the time Brock takes it into his head to come out into the open the wind may have changed and you will find yourself in a position upwind, so that there is little or no hope of his coming right out into the woodland, unless you can move without disturbing him. This is a task which is almost impossible to perform.

ROOTLESS PLANTS THAT BATTEN ON DECAY

EVERY rambler is familiar with the appearance of many fungi, but few even of those who can readily identify bird or wild flower, tree or butterfly, could pass a simple examination in the rudiments of fungus lore, let alone give the names of more than a handful of the enormous number of different forms found in Britain

THERE are so many forms of fungi that, in order to classify them, investigations have had to be carried out in nearly all the different branches of science, ranging from natural history to medicine. They are to be found in countless shapes and sizes, from the "corky" brackets which live on trees, to puffballs, rusts, smuts, mildews, and that immense microscopic class, known as bacteria, or germs, which are the direct cause of so many diseases.

Fungi constitute an enormous class of plants, known scientifically as Cryptogams (Gr. *kryptos*, hidden; *gamos*, marriage), which are characterized by the total absence of the green substance, chlorophyll (Gr. *chlor-*, pale green; *phyllon*, leaf), and of starch, both of which are to be found in all other types of plants.



PARTS OF FUNGUS

The distinctive feature of a fungus is its lack of true roots, the plant growing from a network of fibres.

CRYPTOGAMIC plants discovered by the rambler are confined mostly to those which appear above ground in the well-known "toadstool" shape, growing to at least an inch in height, and sometimes, if the conditions are particularly suitable, to as much as two feet. These fungi may be discovered at all times of the year, even in the very depth of winter if the weather happens to be relatively warm and damp. Their habitats are as numerous as their species, and they may be found on the trunks of living trees, on old pieces of rotting wood, in the hedgerow, or in the very middle of a meadow.

The actual form found by the rambler, although it appears to be growing in the same manner as any other plant, has no real roots, but springs from minute, thread-like *mycele* (Gr. *mykes*, fungus) under the ground or within the body of the wood of the tree. These mycele are the fungus proper, and the part seen above the ground is, as it were, the fruit, produced for the purpose of reproduction. The growth of the mycele underground often gives rise to that interesting pattern made by fungi on meadow grass known as a fairy-ring. The thin, thread-like mycele weave themselves into an almost solid mass between the roots of the grass, being known in this form as "spawn." Growing out from a centre where the first plant originated, the spawn uses up the available nourishment in the soil and so has to spread ever and ever farther out from the centre. Where the nourishment has been used up the mycele in the turf die off, and only those survive which still have relatively fresh earth to grow in. In other words, successive rings of mycele are formed from which at certain seasons there spring up the mushrooms or toadstools giving the fairy-ring effect, the source of so much mystery to country folk and town-dwellers who have no knowledge of the biology of the fungus.

The top, plate-like formation of the fungus is known as the *pileus* (Lat., felt cap), and on its underside are to be seen a large number of fine gill-like *lamellae*. It is on these surfaces that the spores, by which the fungus carries out the process of reproduction, are found. When they are ripe, the wind blowing between the lamellae takes the spores with it and after a time drops them to earth, either to die in some dry and barren spot or to

TOADSTOOL UMBRELLAS

The opening up of toadstools during the natural process of growth is well illustrated in the two pictures shown below. Those on the left are only a few hours old, their pointed tips having served them well in forcing their way through the ground. The right-hand photograph shows them several hours later, when they have opened up to their full extent.

Hosking

germinate in some warm, damp meadow, where they are able in time to give rise to the full-grown mushroom or toadstool, so well known to the observant country rambler.

Minute mycele radiate from the tiny spore, and find their way into the ground, and after only a few days' growth they are able to cover

Waters

FAIRY DANCE-FLOOR

According to an old superstition, still prevalent among boys and girls in remote country districts, the ring of vivid green often seen in the middle of a field is due to the nocturnal dancing of fairies. In this photograph is seen one of the real creators of such rings—the St. George's mushroom, an edible spring fungus.

Waters

LIVING ON THE DEAD

The Stump Flap fungus (*Polystictus versicolor*) is a very common species found principally on tree stumps and dead or dying branches in damp woods. This photograph shows the pilei crowded on a dead hawthorn.

quite a large area. White nodules appear on the surface of the mycele, and these—leaving behind a sheath-like structure called the *volva*—rapidly grow upwards towards the air, and finally appear at the surface as small, stumpy examples of the full-grown mushroom or toadstool. In forcing its way upwards the nodule first of all grows from a stalk and remains for some time still almost spheroid in shape. The time comes, however, when the bottom of the nodule breaks away from the stalk, in much the same manner as an opening umbrella, and leaves behind it a ring on the stalk which can be seen clearly on most of the forms found in the woods or fields.

After its appearance above ground for the first time the young mushroom or toadstool grows very rapidly, and when it is ripe it liberates the spores, which are carried by the wind to " fresh woods and pastures new."

Practical Tests for Edible Fungi

On seeing a fungus of any kind the first question to be asked by the rambler is usually: " Is it a mushroom ? " The term mushroom, it should be understood, is commonly taken to mean any form of edible fungus, though many country people maintain that mushrooms are to be found only in the autumn months, and that there is only one kind. This country has at least twenty safe edible fungi. The easiest way in which to tell the autumn mushroom from other fungi is by the colour of the lamellae on the underside of the pileus. These are at first of a pinkish tint, though if the mushroom is more than a few hours old they may turn to a darker colour or even go black. The popular belief that a fungus is edible if it can be peeled is totally unfounded, as the Death Cap " peels " as readily as the autumn mushroom. Safety lies in a recognition of individual species.

The differences between poisonous and non-poisonous fungi are often exceedingly difficult to detect, and the only safe course is to refrain from eating when there is the slightest doubt.

EXPERIMENTS WITH SPORES

The collection of fungi is in itself a fascinating hobby, but, as a side-line to a collection of this kind, an interesting experiment can be carried out with the spores which drop from the gills under the pileus of most toadstools. If the stem is cut away from the umbrella-shaped top of the fungus when it is still young enough for the spores not to shake off while being moved about, it can then be placed on a sheet of white paper and left in a place where there is no chance of its being disturbed. After a time, when the condition of the pileus shows clearly that all the spores must have been set free, it may be lifted from the paper and an exact reproduction of the shape of the radiating gills will be seen to have been formed on the paper by the spores themselves. This is known as a " spore cast."

It may occur to some toadstool gatherers that it would be amusing to grow their own fungi. Though the true mushroom has been cultivated since the 17th century, very few records exist of success with toadstools. The spores of the edible oyster mushroom (p. 295), however, have been germinated on damp straw and the resulting spawn inoculated into tree stumps, which being kept watered, produced a crop of oyster mushrooms. The blewit has been grown experimentally, and the gills and caps of shaggy caps (p. 296) thrown on suitable soil—*i.e.* fields on which refuse and ash have been tipped—have given a crop of this excellent and unmistakable edible fungus. Here is ample scope for experiment

THE LISSOM LADY OF THE WOODS

UNRIVALLED for daintiness and charm, the birch has never lacked ardent admirers. "Most beautiful of forest trees," Coleridge styled it, and Lowell compared its drooping twigs to the dripping of a dryad's tresses. Here we are concerned not so much with its aesthetic aspect, however, as with its appeal to the discerning naturalist

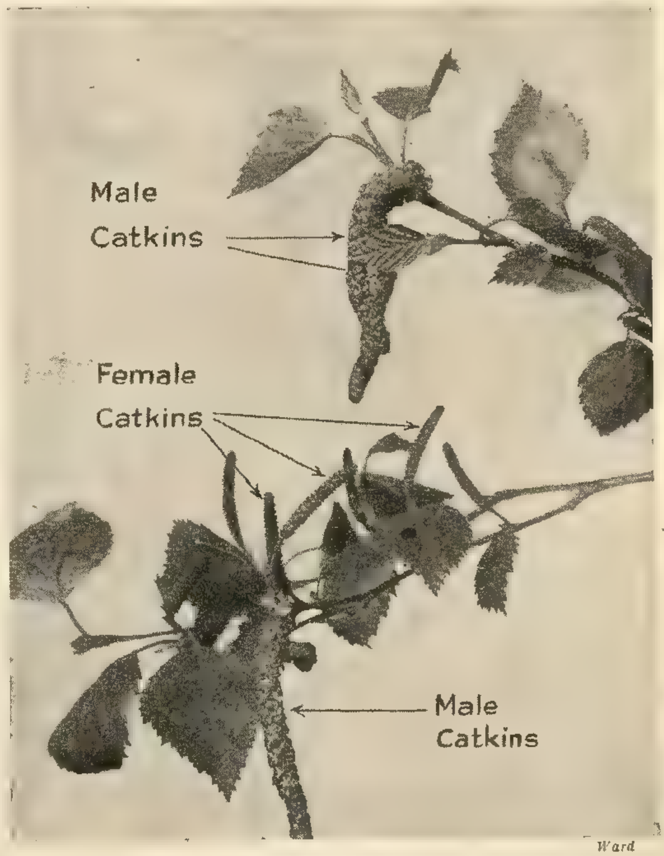
FOUND in every part of the British Isles, the silver birch is undoubtedly one of the best-known of our trees, for it is confined to no one type of country or soil, but can thrive and grow to full beauty almost anywhere. The hardiest of our trees, it is at the same time perhaps the most beautiful, and is, moreover, a true native of the country. For all its delicacy and apparent frailty, it will grow to a good size equally well in the heart of London (there are fine birches in Hyde Park) and as high as 2,500 feet above the sea in the north of Scotland. Outside the British Isles its range is extremely wide; it grows farther north than does any other tree, although when it reaches the limits of its range it is a mere bush of some two feet in height.

ACCORDING to many botanists, there are two forms of birch tree found in the British Isles, but the differences are not of sufficient importance to be given more than a passing notice. The so-called common birch has reddish bark, more or less smooth, the branches are rather close together, and the leaves and young twigs are covered with a soft down. The other and better-known form is the silver birch, which has the silvery bark, dark and rough below, for which the tree is most famous; the leaves and twigs are devoid of hairs, the latter rather rough, and the branches have the typically drooping appearance that is one of the tree's chief charms. The trunk of the tree is single, is straight when it is grown in open conditions, and runs sometimes to as great a height as eighty feet; the average height of a fully grown tree is about fifty feet, when the diameter of the base will be a foot or more. It is a short-lived tree, for few specimens reach eighty years of age, and half that period only is needed to reach maturity.

Ever-beautiful Appearance of the Birch

ONE of the greatest charms of the birch is that there is practically no season of the year at which it is not really ornamental. In the winter the catkins, which are both male and female, form a ruddy haze about the outer parts of the tree, which in the warm light of a January sunset appears to glow with a lovely purple mist. In spring the delicate green of the leaves contrasts strongly with the dark hue of the twigs, and the catkins, larger now and more distinct, serve to enhance the tree's beauty. The male catkins, lightish green, about an inch long, round in section, open and by April have changed to a deep crimson; the catkins are composed of a series of scales which protect the very rudimentary flowers. The male flowers consist of a single sepal and two stamens. The female flowers, which are borne in much smaller, upright catkins on the same twig as the males, are similarly protected, but each bract or scale covers several flowers; they have only two delicate styles that stick upright from the solitary ovary.

The female catkins when fertilized form a little cone-like body, containing for each flower a tiny nut. Every one of these nuts has a pair of wings, and in the autumn the ground beneath the birches may be seen to be covered with the little fruits, which sail down from the opened cones whenever a gust of wind disturbs the tree. These fruits are not the actual seeds, for on very carefully slitting one open with a knife it will be found that the description "nut" is justified. Inside a thin but hard shell the seed itself will be found. The leaves of the tree are of the characteristic ovate shape, the edges being serrated, and some being downy, others smooth, according to the two varieties which have already been pointed out. These leaves are so small, light and airy that they



CATKINS OF THE BIRCH

The flowers of the birch tree assume the form of catkins, erect or pendent according to sex. As is clearly shown in this photograph, the male catkins hang downwards, while the smaller upright catkins are the female. This arrangement is an interesting parallel with that found in the flowers of the beech and the oak, pictured in pages 51 and 79.

in this "lady of the woods," as Coleridge so aptly termed her.

The trunk of the silver birch is often much cut up below, deep clefts being a noticeable feature of the dark, rough bole. Even down to the ground however, we find that the silvery bark may persist, and above about shoulder-level the whole tree gleams with a whiteness of a quality found nowhere else in Nature. This bark may be cut up by dark streaks that run round the trunk, and by patches where at one time small branches have grown out. The branches of the silver birch run out in a markedly upward direction, and the silver bark may be unbroken from stem to branch. As a rule, however, the bark of the branches, at least on all but the largest trees, is dark and the twigs are of a reddish hue that gives the purple glow, already referred to, in the cold winter sunshine.

From time immemorial this bark has been used for writing on, and the variety of the tree found in North America is, in fact, known as the paper birch. This is the tree from which the birch-bark canoes of the North American Indians are made, for its bark can be torn off in far larger strips than that of our native tree. If a strip of bark is pulled off from the living tree, it is seen that there is at least one layer of similar bark beneath, but of a fine salmon-pink colour.

Nicholls

THE SILVERN BIRCH

In the hard, cold light of the winter sun the silver birch shows its lovely bark to the very best advantage. The branching and general method of the tree's growth are emphasized in this picture; notice the strong main trunk with smallish branches growing outwards more or less steeply

give the whole tree an atmosphere that is unique, seeming, in fact, to clothe it in a delicate mist rather than foliage.

As the year wears on, the birch shows us yet another beauty, for in autumn the leaves that have delighted us through the spring and summer with their various greens now turn to a clear and lovely yellow; they fall rapidly, however, and it is as a carpet of yellow on the dark ground that we more often notice the autumnal tints of the birch. When the winter evenings come again we find reddish hues on the bark of branches and twigs, unnoticed beneath the foliage of summer, which give a warmth to the landscape and afford us a final delight

As a timber tree the birch is of but little value, for, though moderately hard, the wood has not such lasting qualities as that of the beech; it is, however, extensively used for veneers in modern furniture, the grain and the fine colouring, a clear, bright yellow, making it especially attractive with other light woods. To its lack of value as a timber tree we can put down the poor esteem in which it was held by our ancestors, who were blind to its real beauty. The diarist, John Evelyn, in his famous "Sylva," speaks of the tree itself as despicable, but then refers to the "sovereign effects of its juice," going on to give a recipe for making the birch wine, of which he highly approved. The art of tapping the tree for the juice or sap, which comes up in a remarkable rush in the early spring, is also described. The trees should be tapped on the south-west side only, in March, when the sap is rising at its strongest, several incisions being made in each trunk. A single tree could be made to give several gallons of clear juice, which, when fermented, would make the wine which was in those days the sole redeeming feature of the tree. A powerful, spirituous

drink, it was recommended, as were almost all alcoholic liquors, for medicinal purposes.

Other uses for the bark are dependent upon its great value for waterproofing; this is due to the large quantity of resin that it contains. A cloak of the bark is completely waterproof. Like many other barks, birch-bark was at one time extensively used in tanning, and the smell that is characteristic of Russia leather is due to the use of birch-bark oil, which is used as a tanning agent.

ALTHOUGH, as has been pointed out, the birch may be considered an almost ubiquitous tree, there is one definite "association" in which it plays a most important part. This is what can best be described as the birch-bracken-heather association, which is characteristic of sandy soils, and which may arise in a number of ways. One can often see this collection of plants and trees in a place where a large pine wood has been cut down and completely removed, a condition that occurred only too frequently in the south of England during both World Wars. When the ground has been left bare, the first plants of real importance to spring up are birch seedlings and heather. The heather has probably been present in a very minor degree round the edges of the wood, and the birch may also have been there; birch seeds, armed with their pairs of tiny wings, are admirably adapted to wind-dispersal, and sooner or later a few of them will arrive on the bare ground where the pine wood once stood. The seedlings are at first tiny affairs of only two rudimentary leaves, as is the case with all deciduous tree seedlings, but they soon spring up, and by the end of the first year may be more than a foot high. The young trees grow at an average rate of a foot a year, provided that they are not nibbled by cattle or rabbits, being very hardy and quite able to compete with any rivals in the

MIRRORED GRACE

Tall and slim, their white trunks crowned with lovely heads of delicate green foliage, these silver birches seem to be gazing at their own slim forms reflected in the pool.

Photo. Horace Nicholls

Hosking

Dennis

CHARACTERISTICS BY WHICH THE BIRCH MAY BE RECOGNIZED

At the base of the silver birch's slender trunk the fine bark lacks the smooth, silvery consistence of the upper branches, being cut up by fissures and cracks of darker and rougher texture. The little splits across the silvered portions are known as lenticels. The right-hand photograph shows admirably the ripening fruits and leaves of the birch. The triangular form of the leaves, with their remarkably straight veins, is easily seen, and the fruits, products of the female flowers shown in page 107, weigh down the branch with their cargo of maturing seeds

vegetable kingdom. By the time they are twelve years old they are able to bear fruit, and at once the community is firmly established. Even before this time it is remarkable how a wood of young birches can appear where formerly was a barren waste of pine-needles.

Few ramblers can have failed on occasion during their wanderings to come across the typical open birch wood; the birches, tall and dainty and slim, accompanied by bracken, making with its green fronds a carpet three feet above the ground level, and, where the bracken is less thick, the heather and heath grasses. Then comes the ubiquitous bramble, making rapid headway once there is a topsoil of birch and other leaves, and providing a thicker undergrowth that is itself the home of many birds and insects. Birch leaves make a very dry, warm bed in the summer, and the community described above is often the haunt of lizards and even adders. In the bushes round the base of the tree willow warblers and white throats build, feeding on the insects of the trees above.

Beetles that Live on the Birch

Although it has not such a large insect fauna as many trees, the birch will yield the inquiring naturalist some very interesting species. Amongst the most noticeable of these is the birch leaf-roller weevil; its handiwork can be seen often in the summer, when one finds leaves that have been cut in half, except for the midrib, the lower half being rolled neatly round into a little green cone. In this the beetle has laid its egg, and the tiny grub will hatch out and feed, falling to the ground when the leaf-tip itself dies and falls off. The beetle is a rounded, small, chestnut-brown insect, provided with the long snout characteristic of the weevils.

The branches of the trees may often be infested with what may be at first mistaken for a bird's nest—a large accumulation of twigs that is woven round the branch. This is a growth known as the witch's broom or witch knot; it is made by the working of a minute fungus, which alters the arrangements of the cell tissues and causes a mass of small shoots to be formed at one point.

The caterpillars of a number of moths may be found on the birch, most of them being of the "looper" or "stick" type, small thin green creatures that stand perfectly still for hours and are almost indistinguishable from twigs.

Fungi in the Birch Shade

Beneath the tree, on the surrounding soil, there may be seen in autumn one of our finest fungi, the fly agaric, so called because its poison may be used in fly-papers. It is a crimson-capped toadstool with whitish spots, the stem creamy-yellow and with a light frill hanging all round about half way up it. The trunk of the tree is the host of a large parasitic fungus, a hard bracket type which sucks up the sap through the bark.

We may in winter or early spring find sitting on the trunk the wingless females of the mottled umber moths, a most interesting series of insects that is dealt with in a later page.

To the forester the ability of the birch to grow very rapidly during the first few years of its existence is of considerable value, and birches are planted as shade trees or "nurses" in plantations of slower-growing conifers that will need protection from the weather during their early years. The birches grow up rapidly and afford this shelter, but as soon as the conifers are of an age to withstand wind and weather the "nurses" are ruthlessly felled. The "birch-rods" of the old-time schoolmaster were made of a number of the slender twigs bound together, and some garden brooms are still made, in much the same way, of tightly-bound birch twigs.

TWO EXQUISITES OF THE BUTTERFLY WORLD

Two of the most beautiful butterflies of the whole of Britain's range are described and pictured in the following pages—the Brimstone or Sulphur and the Orange Tip. Among the most beautiful, they are also among the most popular, for they are widely-distributed and make their first appearance in the early days of spring

THROUGH the woodland glades, flitting in and out among the trees, a bright yellow butterfly may catch the rambler's eye. Large and of apparently weak flight, it suddenly and completely vanishes from view, reappears with equal suddenness, and then disappears again. The butterfly is the Brimstone, or, as the old naturalists called it, the Sulphur, and it is one of our earliest and most delightful insects. Actually the specimens we see in early spring, or even, if the sun is warm and strong, on some winter days, came from their chrysalids the previous autumn, and have slept through the cold and windy days of winter.

The Brimstone and some of the butterflies of the Tortoiseshell family are among our longest-lived butterflies. There is a very slight possibility of a few individuals remaining in the pupal stage throughout the winter, but even the fine and undamaged specimens that we may find in late May or June have probably spent ten months or so in the perfect state. If the butterfly is examined closely, it will be seen to be of a uniform bright yellow colour, having a vermilion spot towards the front of both fore and hind wings; the female is considerably paler than the male.

A FURTHER feature that we cannot help noticing is the very unusual shape of the wings, which curve back a little at the outer front edge, coming to a sharp point.

Now let us watch the butterflies on the wing in the wooded glade once more, and this time, very, very carefully. As before, they seem suddenly to disappear, not behind a tree or bush but into the very substance of them. Let us approach them quietly, very cautiously, and above all, making no quick movements; a butterfly cannot actually distinguish between friend and foe from their appearance, but is frightened by the sudden fall of a shadow or by a quick movement which catches the light—its eyes, in fact, comprehend colour and light and shade, rather than form. The bush which marks the spot where the Brimstone disappeared has pale yellowish-green leaves, and among them the insect has settled; suddenly we see it sitting very still on a twig, or perhaps on the stem or the underside of a leaf. We see it, in fact, so clearly that it seems extraordinary that we did not notice it at once, but if we glance away again, and then look back, it is gone —until we find the same twig and realize that it still sits there. The value of the curious shape of the wings becomes apparent when we see the insect at rest. The fore-wings shut down inside the hind ones, only the points projecting, and the greenish undersides give a perfect reproduction of the leaves which surround the insect. Many other insects practise this "protective resemblance," but there are few in this country that will show us so well how to disappear by simply sitting still.

Ward

ORANGE TIP PHYSIOGNOMY

This close-up picture of an Orange Tip butterfly shows the beautiful furry clothing of the newly-hatched insect. Even the legs are covered with hairs, and the head has a crest which extends backwards on to the thorax. Note the tongue, so neatly curled up in front of the head; the antennae, organs of touch; and the semi-globular eye. (× about 9.)

Laying the Eggs

IF the incident described above takes place in May or June we may see the butterflies chasing each other and courting all through the wood, and perhaps, by watching the pale female very closely, we may see her laying her eggs on the undersides of the leaves. The plant she favours, and the one on which the butterflies are most fond of sitting, is the buckthorn, a slender shrub that may grow into a small tree, and one which is common, though scarcely noticed, in most of the woodlands of England. In all its stages, the Brimstone closely resembles some part of this tree.

Conical, but not quite pointed, the eggs are beautifully ribbed, at first green in colour, then yellow, then greyish; from them in a short while hatches the pale green caterpillar, which spends most of its time holding itself rigidly along the stems, thus avoiding being seen by hungry birds or other enemies. It is, in fact, as difficult to see as the adult insect. When fully grown it is green all over, with a pale line along each side; if we examine the caterpillar closely, we see above the line a series of little round marks, one on each of the segments of the body, except

the second, third and last. These are called spiracles and it is through them that the caterpillar breathes.

A little later in the year, in July or August, we may also find, slung below a leaf by a single silken thread, the pupa or chrysalis. This is of a very remarkable shape and appearance. In colour it is bluish-green, with a yellow, beaked projection in front and brownish patches at the bases of the coverings of the rudimentary wings. The wing-covers themselves project considerably on the lower side of the pupa, that is, the side nearest the surface of the leaf, and are of a brighter green than the rest. Thus even at this stage the insect protects itself by resemblance to a plant, for at a casual glance it appears merely to be a curled and dying leaf. This pupa may only be found during July or August, for in the summer the perfect insects emerge. We may thus see them on the wing almost throughout the year ; the adults of the former brood may only have finished their egg-laying a few weeks before the members of the new generation are on the wing.

Ornate Colouring of the Orange Tip

In the meadows, where the pale mauve flowers of the lady's smock show that the ground is moist and the field marshy, we may see in the spring another of the most distinctive of our early butterflies. At first, perhaps, as it flies over the flowers of this and other plants, we mistake it for the Small White, or the Green-veined White, which is commoner in such places ; but a glance will show that there is some brighter colour about it, and when it settles we notice that the outer halves of the fore-wings are of a very lovely and brilliant orange colour, with black at the front corner. One black spot in the centre of the wing, and a series of them round the edge of the hind wings, complete the decoration of the Orange Tip, as this insect is aptly called. The under-side, however, reveals fresh beauties, for while the bright colour of the fore-wings is reflected in a paler orange, the hind wings have their lower surface covered with a checkered pattern of darkish green and white.

Among the lady's smock plants, too, may be seen what we are almost sure is a White butterfly of some sort, for there is no orange mark on the fore-wings ; it is only when the insect settles that we see the characteristic pattern on the undersides of the hind wings. This is the female Orange Tip, often slightly larger in size than her more brightly-coloured mate, and so often confused with a Small or Green-veined White that she seems a far less common insect than the male.

DEVELOPMENT OF THE 'BRIMSTONE'

The series of photographs in this and the opposite page covers the development of the brimstone butterfly from egg to adult insect. The top left-hand picture shows the egg (× about 30), and next are four life-size pictures of the caterpillar. A point to notice is the likeness of the larvae at all times to the stems and leaves of the buckthorn on which they feed ; their colour is similar to that of the leaves, and their simple form and absence of hairs make them almost indistinguishable from the stems at a casual glance. This protective resemblance is still more marked in the case of the pupa, seen in the sixth photograph. In form the pupa is exactly like a folded and slightly crumpled leaf, while its pale bluish-green colouring matches its environment to perfection.

By laying her eggs on the lady's smock and on many other plants of the same family the Orange Tip shows the same preference for plants of the mustard tribe as do the common White butterflies. The egg, shaped like an elongated barrel, is laid actually on the flower stalks, and the caterpillar, when fully grown, bears an extraordinary resemblance to the seed pods of the food-plants. Pale green above, with a white stripe dividing this from the dark green underside, it stands rigidly along the midrib of a leaf, the rest of which it has eaten; so close is the resemblance that even when one knows exactly what one should be looking for, it is extremely difficult to detect.

Hibernating in the Pupal Stage

The pupa is also of a remarkable shape: triangular in outline and sharply pointed at both front and rear ends, it is palish grey in colour. The insect may remain in the pupal state from August until the following May, and the latter month is the most usual for the first appearance of the adult insect. In an early year it may be seen in April, and, as with all insects, the farther north we are, the later we may expect to see it on the wing. Very occasionally specimens appear late in the summer—perhaps a second brood, but more probably insects that have been delayed in the pupa for a whole year.

Each of the butterflies with which we have dealt above is a member of the same family as the three species of Whites described in pages 37–42; besides the five we have now introduced, there are five other species found in the British Isles, all fairly closely related.

One of our Rarest Butterflies

Of these, three are rare, one indeed so rare that not a hundred specimens have been accurately recorded within our shores. This is the Bath White, so called, we are told, "from a piece of needlework executed at Bath by a young lady (about 1795) from a specimen of this insect, said to have been taken near that place." It was also known, from its parti-coloured appearance, by the delightful names of "Vernon's Half-mourner" and the "Greenish Half-mourner." This butterfly is mentioned here, not only on account of its great rarity, but because the underside is very similar to that of the Orange Tip, a fact which may have let many specimens remain undetected. The upper side is white, with black and white chequered markings on the fore parts of the front wings, and, in the female, black marks on the rear edge of the hind wings. The butterfly, which is an immigrant from the Continent, has been caught chiefly on the south and south-east coasts in July and August.

Another rare insect is the Black-veined White, a larger butterfly than the Large White, and quite devoid of

STUDY IN PROTECTIVE MIMICRY

Continuing with the brimstone's life history, we see first (7) two pupae, each attached to a twig of the food-plant at its rear end and supported by a single thread of silk spun by the caterpillar before pupation. In the next four pictures (8-11) stages in the emergence of the adult insect are seen. The pupa splits open along the back at the fore end, and the insect drags itself clear. The wings, at first crumpled and soft, expand and harden, and by the time they are fully open the insect from the lower chrysalis has also emerged, and is seen hanging from its empty pupal skin, while its wings are almost fully expanded. In the last picture of the series the butterflies are resting after their first flight.

Photos, J. J. Ward

It may be as well to give here some idea of the sub-families into which our butterflies are divided. The insects dealt with so far have been members of the *Pierinae*, before which systematists place the *Papilioninae*, a sub-family of which our sole representative is the Swallow-Tail. These two compose the family *Papilionidae*, and it is followed by the *Nymphalidae*, a group containing the sub-families, *Apaturinae*, *Nymphalinae*, *Danainae* and *Satyrinae*. The first and third of these give us a single species each, namely the Purple Emperor and Milkweed butterflies. The other two contain the tortoiseshells and fritillaries, and the Meadow Browns and Heaths respectively. The great group *Lycaenidae*, with its sub-family *Lycaeninae*, contains the Blues and Hair-streaks, and the *Hesperidae*, with its sub-families *Hesperinae* and *Pamphilinae*, comprises the Skippers.

Ward

CATERPILLAR CAMOUFLAGE

In this most interesting picture caterpillars (indicated by arrows) of the Orange Tip butterfly are shown at every stage of their existence. So closely, however, do they resemble the seed-pods and stems of their food-plant, the oft-encountered lady's smock or cuckoo-flower, that they are almost invisible even in the photograph, and in the wild they would not be seen even in profile.

Ward

SAFETY IN SIMILARITY

Of the many forms adopted by the pupae of butterflies, not the least curious is that of the Orange Tip. Attached to their food-plant by a single thread the chrysalids (indicated by arrows in this photograph) closely resemble the plant's seed-pods. From these narrow, leaf-like skins whole butterflies will emerge in all their beauty in the course of a few days.

markings, the distinguishing feature being the veins of the wings. This fine butterfly is now confined to one locality in Kent, near the Isle of Thanet, but was formerly widely distributed though always local.

The Wood White is found by thick woods in various localities all over the country. A graceful and delicate little insect, it has longer, narrower wings than its relations, the males having a black smudge near the front margin, the wings of the females being plain. The caterpillars feed on small, low-growing plants of the pea family, and are green in colour, with lines of yellow along the sides, dark green down the middle of the back, and innumerable black dots on the front segments. This butterfly has spring and summer broods.

COLLECTING BUTTERFLIES. 2

Provided with killing bottle and net, the intending collector of butterflies may set out, but although these are the sole absolute necessities, it is as well to have a few other items in one's equipment. Small pill-boxes, preferably with glass bottoms or tops, are of great value; many butterflies will remain quite still in a pill-box, and, if they are females, this is a good way in which to take them home for purposes of breeding. Small tins should be taken for caterpillars or pupae that may be found during the day, and a small collecting-box, lined with cork, is a great advantage on a long day's collecting.

Most butterflies die in a few minutes in the killing bottle, and they should then be taken out and pinned up in the collecting-box. This saves many specimens, for in the chase of some rapid-flying insect those in the killing bottle may get severely damaged, and at the end of a long day a large proportion of the "bag" may be worthless if they have all been rubbing each other's wings and jolting up and down in the bottle for several hours. When any caterpillars are found they should always be put in tins with some of the food plant on which they were found, and if it is a plant that does not grow near the collector's home, it may be as well to take back a good supply

Searching for Pupae

A branch of collecting which often repays close attention is that of specializing, for a time at any rate, in the search for pupae. This work has the advantage that it can be carried out during the winter months, for the majority of moths spend that period in the pupal state. Likely localities are rotten trees, or those in which the bark is loose, leaving a cosy space behind, which may be full of insects; the cracks of the bark of such trees as old oaks, in which case the cocoons must be looked for; palings and walls, especially on the borders of woods; and the thick moss beneath large forest trees.

The implements required for this work consist of a pair of good forceps with the ends splayed out, not sharply pointed; a small trowel, very useful for work in moss and the soil of the woodlands; and a number of small tins or boxes. It is as well to keep each pupa separate, at least until some record of the situation in which it was found has been made.

ORANGE TIPS AT THE FEAST

Altogether pleasing is this picture of male and female Orange Tips feasting on the flowers of one of the big Umbelliferae. The wonderful patterning of the insects' undersides is seen to perfection, and the way in which its checks match the white flowers and dark shadows show that a seemingly-conspicuous insect may become almost invisible in the right surroundings. The picture is enlarged so that the butterflies are not quite twice actual size.

CAUGHT BY THE FLASH

Disturbed just as about to leave his sett, Brock is too surprised to retreat into the safety of his underground home. The darkness is usually his surest ally, and now that the photographer's flashlight has suddenly illuminated the woodland the badger feels himself dangerously conspicuous.

OUT IN THE STILLY NIGHT

When engaged in his nocturnal perambulation to make sure that no harm has come to his youngsters, whiling away the hours of darkness in their woodland, arena-like playground, Brock has been suddenly halted by the blinding glare that accompanies the clicking shutter.

SOMNOLENT BULK

Stretched on its rocky bed, this huge grey seal, evidently just about to take "forty winks" in the sunshine, reveals the barrel-like formation of his body, his front flippers (so admirably suited to swimming) and his hind legs merging into the broad and powerful tail.

CALLING ITS MATE

From its attitude one would think that this seal is yawning, but actually it is roaring to its mate. The rolls of blubber under the skin are very noticeable, as well as the manner in which the hind flippers are moved. Both this and the photograph above were taken on the coast of Cornwall.

DIGNITY ON THE DEFENSIVE

Just returned from a foraging expedition, this Great Tit is naturally concerned and not a little offended at finding that during her absence the inquisitive photographer has removed the back of the nesting-box with the result that the well-built nest and the clutch of speckled eggs are exposed to public view.

AVIAN ACROBATS ON A LEAFY STAGE

THERE will be few to cavil at the statement made below—that the "titmice" are the most popular of all our birds. So beautifully coloured are they, so agile in their movements, so amusing in their antics and so ready to make friends with their admirers, that they are firm favourites with every bird-lover

EVERYONE who has ever fed the birds in winter by hanging coconuts or lumps of fat up outside his windows, has made the acquaintance of the tits, the most popular of all our birds. Known generally as the titmice, they form the family of the *Paridae* within the great order of the passerine birds. Characterized by small, neat bodies and small, rather pointed beaks, they are remarkable for their agility and restlessness, and for the acrobatic feats with which they delight us. Although from their tameness and from the willingness with which they will come to the feeding tray, they are seen at close quarters far more often than any others of our birds, they are none the less very little known, except by the general denomination of "titmice."

In actual fact we have in the British Isles seven species, of which two are so rare as to be outside the field of all but the specialist; the other five, however, are all common birds, and birds that every rambler should be able to tell at a glance. There should be no very great difficulty in distinguishing between them, for they all have well-marked characteristics in plumage as well as habits

Titmice may be divided into three groups: first, the great tit and the blue tit; secondly, the cole and the marsh tits; and, finally, the long-tailed tit. The two rare species are the bearded tit (of the family *Panuridae*) and the crested tit. Taking these groups in the above order, we have first two birds each of which has a certain amount of bright colouring, yellows and blacks and blues, that attract the eye particularly. The great tit and the blue tit are frequently confused, but once one has come to realize their differences there should not be any difficulty in their immediate identification.

THE great tit is the largest of our tits, as well as the most handsome. The head is black, as also are the neck and the throat, and a stripe of the same colour runs from the throat along the underside towards the tail, making a feature by which alone the bird is easily identified, especially as it is usually seen from beneath. The cheeks are a pure white, and there is white beneath the tail, on the tips of the tail coverts, forming a bar on the wing, and along the outer edge of the tail itself. The underparts are elsewhere brilliant sulphur-yellow, and the back is gradually shaded from a white or yellowish spot at the nape to olive green down the back and along the sides. The wings and tail are blue-grey, and the tail—as in all the tits—is forked.

The general make-up of the great tit is in character with his appearance. Watch him when he comes to the lumps of fat hung up for the birds in winter, or when he alights on the bird-tray that is covered with tasty scraps. A flurry of wings and a flash of yellow herald the appearance of this bully of the small birds. First, every other bird is chased away, even thrushes and blackbirds being attacked and driven off; then he sets to on the choicest morsels, stopping from time to time to evict some blue tit that has dared to peck away in the far corner of the tray, scolding and flying at every other bird that even attempts to alight, quarrelling with other great tits if they happen to arrive. Yet for all his aggressive manners and bullying ways, we cannot help admiring him in his smart suit of yellow, black and white.

Chief of the Titmice Troupe

ON the bird tray, too, we have ample opportunity to study the blue tit, whenever his larger cousin gives us a chance. If the great tit is the bully of the family, the blue tit, or tomtit, as he is often called, is the humorist, the chief clown, the leading acrobat. Pert, neat, energetic in the extreme, he is one of the most popular of all our birds, and deservedly so, for no other bird can do so much to amuse us when, the frost having gripped all Nature in an icy vice, the birds flock to the gardens in search of food, while we sit safe and warm behind the windows. As soon as the feast is spread, from out of nowhere come

MOST HANDSOME OF THE TITS

The great tit, largest and most handsome of the tit tribe, is most at home in woodland districts where the cover breeds the insects which are his favourite food. Here, sitting at the entrance to his nesting-hole, he has posed for the photographer to his own advantage, showing off his fine bearing and powerful beak.

Fletcher

the blue tits, buzzing on whirring wings to be the first for a meal. Whatever we put on the tray or hang from a post or wire, the blue tit will eat it and at the same time give us a display of his ceaseless acrobatics.

THE chief feature of the plumage of the blue tit is the bright blue crown, with its darker stripe that passes across the eye to the beak, where it meets a ring of blue that encircles the whole face; the nape of the neck, the wings and the tail are also bright blue. The underparts are sulphur-yellow, with a slighter black stripe than in the great tit; this stripe often does not reach up to the chin. The cheeks and forehead are white, and there is a white stripe behind the eye; the back of the blue tit is greenish.

When the blue tit is excited—which happens not infrequently—he raises his crown into a little crest, making the beautiful blue even more apparent; this blue, and his size—less than 4½ inches in length compared with the 5¾ of the great tit—are the surest ways of telling him from the larger bird. Despite its small size, however, the blue tit is always willing to fight any other small bird, especially its own fellows, and there are few more amusing sights than that of a pair of blue tits chasing each other round and round, while a third bird hops quietly in and devours the food that is the cause of the argument.

The second group of tits comprises two birds that are certainly very much alike at first glance, both the cole and the marsh tits having a general make-up of black and grey. In both birds the top of the head is black, the cheeks white, and the underparts buff-coloured, shading into darker brown under the tail. The cole tit, however, has a characteristic white patch at the nape of the neck, which serves to distinguish it, not only from the marsh tit, but from every other bird. There is the same white wing bar as was present in the great tit, and the black patch beneath the beak stretches well down to the throat, ending rather abruptly. The underparts shade from white at the throat to brownish buff under the tail, and the back is olive-brown.

Marsh and Willow Tits Compared

OUR next subject, the marsh tit, is now divided by most ornithologists into two sub-species, the marsh tit and the willow tit. The true marsh tit has a blue-black head, while that of the willow tit is brownish-black. The cheeks are white, with a black chin, and a little black appears on the throat; the smaller expanse of this black, and the absence of the white nape distinguish these birds from the cole tit, and both marsh and willow tits are rather slimmer birds, although actually about a quarter of an inch longer than the cole from beak to tail. The white wing bar is absent, although in the willow tit there is often a very pale buff patch on the closed wing; otherwise both birds are brownish above, whitish below, shading into buff under the tail.

The last of our common tits, the long-tailed tit, is one of the most distinctive of all our birds. Its name alone

Hinkins

GROOM TO BRIDE

In the spring, while the apple blossom is still on the bough, the two blue tits seen in this photograph have plighted their troth, and the male is sealing the understanding with a gift to his affianced of a luscious caterpillar. The blue crest on the top of his head is not raised, but the white cheeks and eye-stripe are quite characteristic of this charming little bird.

Workham

SOMEBODY'S TIT-BIT

Eight long-tailed juveniles sit in rows on a branched twig while the mother tit decides which of them is most deserving or most in need of the choice morsel she has managed to secure. Unlike the other tits, the long-tails are confined to an insect diet, and for this reason they spend most of their time in the woods and hedgerows, where such food is to be found in most abundant measure.

betrays it, for the long, narrow, straight tail—as long, in fact, as the rest of the body—singles it out from all other birds in an unmistakable fashion. Long-tailed tits are far more often seen in winter than in summer, for they are essentially birds of the woods and of the thick, bushy places, and it is only when the leaves have fallen that we really notice them. Then, with their long, straight tails and round, tight, little bodies, they resemble nothing so much as a company of tiny, animated rockets as they flit from tree to tree in little companies, uttering a continuous, single, high-pitched note, *tzi, tzi, tzi*, as they search the branches for food. These tits are entirely insectivorous, and, though they are amongst the best friends the gardener can have, they never come to the coconut or row of bones that may have been hung out for their cousins' benefit.

Family Spirit among the Long-tails

SUCH little flocks of long-tails are among the most characteristic features of the countryside in winter, for the birds keep together largely, and do not, like the other tits, collect in companies with other species. This is due, no doubt, in part to the fact that the families keep together, for there are often as many as twelve tiny tits in one family, and the skill and completeness with which they examine every twig on a bush would leave little scope for any other birds.

In plumage the long-tailed tit differs widely from its relatives. The head is whitish, with a broad black band above the eye, running into a black patch at the nape of the neck and down the back. The rump and the scapulars are of a warm rose-pink, the wings are brownish-black, with white edges to the secondary feathers, while the margins and tips of the outer three tail feathers are also white. The whole bird is white below, with a warm, pink tinge which becomes more noticeable on the breast and the sides. It should be noted that the tail feathers, which fold under each other, are graduated in length, so that only some of them are the full length.

The nest of the long-tailed tit is the finest example of the art and craft of nest-making that we have in the British Isles. It has earned for its maker the popular name of "bottle-tit," being oval, with a hole in one side (*see* page 143). It is usually situated in a hedge or thick thorn bush, or, if such is available, a gorse bush, and is the result of as much as a fortnight's almost continuous work on the part of both birds. When finished it is a work of wonderful beauty, not only in construction but also in appearance. The materials are wool, moss, hair, lichens, gossamer from spiders' webs, and a final layer of grey lichen round the outside, while the lining, itself a work of art, is made entirely of feathers. As many as two thousand feathers have been counted in a single nest, and the mystery of how they are packed into a thick-walled oval, whose height is some five inches, is one that the bird alone can solve. There are from eight to twelve eggs, pinkish-white in colour, and speckled more or less finely with reddish. When sitting the bird, by doubling

Markham

TWO TITS ON THE THRESHOLD OF THEIR HOMES

At first glance so much alike, the marsh tit (left) and the cole tit (right) may be readily distinguished on closer examination. The marsh tit is a slightly larger bird than the cole tit, and its black head lacks the splash of lighter colour on the nape of the neck which is a reliable identification-mark in the case of the cole tit. The whole tone of its plumage, too, is warmer, [illegible] rather than black predominating. The smallest of our tits, the cole tit is a bird of the woodlands, but it seems to find a home in a crevice in an old wall just as congenial as one in a hollow tree. The one seen above is apparently removing a chip of wood from the side of its new house.

herself up, has both the end of her tail and her head in the entrance hole; and at night, when there are a dozen youngsters as well as the roosting male parent in the nest, the congestion must be considerable.

As regards nesting habits, the other tits are all more or less dwellers in holes, either in trees or walls; the birds sit very close, and if a hand is thrust in when they are on the nest, they will peck at it valiantly, hissing and spitting so long as the intruder remains. But the birds will usually allow themselves to be taken out without much trouble, and they will after a while become quite tame. The willow tit, and possibly the marsh tit, make their own nest-holes in rotting trees and all the four species will visit the artificial nesting box with freedom; blue tits, in fact, are usually the commonest guests in such places, and a pair will return year after year to the same box or hole. A very favourite place is the tube of a disused pump, a drain pipe, or any round hole that is cosy and can be sealed against draughts; the cole tit often uses old nests of magpies or squirrels.

The eggs, which are laid in April or May, number from seven to a dozen or more, all the species laying the same type of white egg with reddish-brown spots.

HINTS ON BIRD WATCHING. 3

One of the many ways in which birds differ to a very wide degree is in their behaviour on the nest, and this applies not only to different species but to individuals.

In previous notes the beginner in bird-watching has been brought from his first observations of the birds to the discovery of the nest of such a bird as a blackbird or thrush, placed, say, in the branches of a bush not yet in full leaf, allowing a fair view of the nest when the birds are present.

Care should always be taken in approaching a nest, even if the bird is not sitting. The birds should never be frightened off, or they may desert the nest. Approaching as gently and quietly as possible, we see first if the nest is vacant. If it is, and if the birds are not heard anxiously clucking in the bushes near by, then we can look and see how many eggs there are, or whether the young have hatched. Having satisfied our curiosity, we should retire to a place of concealment, whence we can watch the nest, and then wait. Sooner or later, provided that we keep still and quiet, one or other of the birds will return. This is where the note-book comes in handy.

Points to Note

Note which bird it is and, if it is the male, whether it settles down on the eggs or not. In many birds both sexes sit on the eggs, in others the female alone does this, the male singing to her and feeding her. If the first arrival is the female, we may see her turning the eggs round, or cleaning and tidying the nest.

When the female bird is found sitting, do not disturb her. Try to find out if the male is sitting singing on a neighbouring tree, or wait and see if he comes to feed her. In the latter case, see what the food is, if possible, and note how often he comes, whether the visits are at regular intervals or not, etc. In some cases the male shares in all the duties of the home, from building the nest to feeding the young, but in others he sets a shameful example of selfish indolence, sitting singing all day long and never stirring wing to help his harassed spouse in her tasks.

Noticing the food of the bird is important, for thereby we may obtain some idea of the places to which it must go for its provender, and if we can manage to identify the exact species of caterpillars or insects on which the female or the young are being fed, we may feel that we have already done some original research.

'PALM' BOUGH EMBLEMS OF EASTER JOY

In Rome, wrote Goethe once, they bear true palms on Palm Sunday; elsewhere olive branches and holly boughs supply their place; while "more northern climes must be content with the sad willow." It is this willow that is the subject of the second article in the series of which the first is "Spring Comes to the Countryside" in page 3

Just as holly is the traditional tree of Christmas, so is "palm" the customary decoration in home and church, in town and country, at Eastertide. Along the hedgerows it makes a fine, golden mist, providing at the same time the first real harvest for the bees, and brightening the dullest landscape. Decorative and attractive at a time when there are few flowers in the hedgerows and the rest of the world is rather bare, it is to most people just a sort of willow. Few of us remember in later summer the joy which this humble tree gave us when it showed us that winter's long reign was at last over.

The goat willow, or sallow, to give it its two proper names, is in actual fact one of the most distinct of our many species of willow, several of which are so closely related that most botanists class them as mere sub-species. Although the sallow itself varies considerably, it is a well-defined species, for it has but little in common with the lovely weeping willows of the riverside or with the slim purple wands that fill the osier beds.

Grown to its fullest extent, it is a tree of thirty feet at the most, and is more usually twenty feet in height; the stem is sturdy, though nowhere very thick, and the bark is grey and slightly rough to the touch. The leaves are ovate, pointed in the typical form, but ranging in some of the varieties from almost round to a true lance-shape. They are dull grey-green in colour and smooth above, the undersides being covered with soft white down, and they grow alternately up the stem. At the base of the leaf stalks is a pair of very small green bodies like minute leaves; these are known as stipules.

The feature of the sallow which constitutes the "palm" is the catkins of male flowers, for in this species male and female are found on different trees. In very early spring they are already noticeable in the hedgerows as lines of silvery buds all the way up the stalks, being known at this time as "pussy willows"; when they grow, swell and finally open, they turn their silver to gold, and the season of "palm" is here. Each male flower consists of a pair of long stamens, like little golden pins, whose heads are the anthers; these stamens grow out from a little dark scale that is edged with the silver hairs. The female flowers are silver, too, when in bud, for they consist of a conical ovary which is borne on a similar scale; the silver fringe is responsible for the appearance of the catkins in their early stage.

Dennis

EASTER PALM

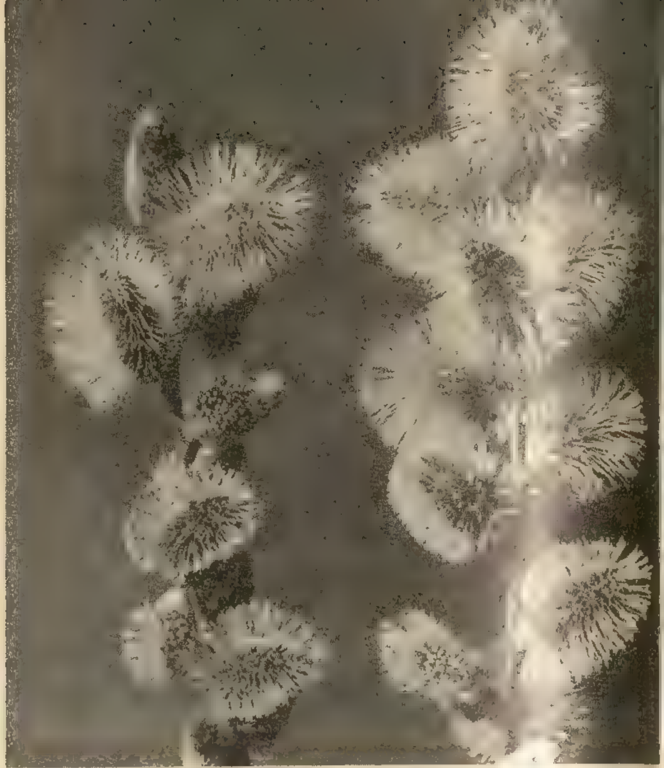
The "palm" that is so conspicuous in our Easter decorations is in reality the goat willow. This photograph shows the very rare case of male and female flowers growing on the same twig.

When they grow and open, these female catkins elongate considerably, each ovary swelling and giving the whole inflorescence a greenish colour. Later still, when they are ripe, each ovary splits open from the top, the two halves curving backwards and revealing a number of little seeds, each of which bears at its tip a tuft of long, silver hairs. These give the whole catkin an appearance of cotton-wool, and the sallow at this time becomes again a conspicuous feature of the countryside. These hairs have a twofold function; first, they act as parachutes in helping the ripened fruits to travel on the wind for some distance from the parent plant, and, secondly, they perform the service of anchors when the fruit has fallen to the ground.

Among the several well-marked varieties of the sallow, the grey sallow and the eared sallow are the two most important. The former has the leaves downy on the upper as well as the lower surface, the twigs and buds also being covered with white down; the anthers are of a much paler colour and the female seed-capsules are smaller. A much smaller tree, the eared sallow has long, straggling branches and reddish twigs; the leaves are small and oblong, with larger stipules. Both of these forms are more fond of moist places than is the true sallow, and the eared sallow is also a mountain species, being found in habitats as high as 2,000 feet above sea-level.

There are also a number of dwarf willows, some of which are known as dwarf sallows, which are well-distributed all over the country. Of these, the group of shrubs that are classed as the dwarf silky willows are of common occurrence, especially on heathy ground. They are not unattractive little plants, for the whole of the leaves, buds and often the young stems are covered with fine, silky hairs. The catkins are possessed of the characteristic bright yellow colour, as in the true sallow, and the seed capsules produce in summer the same mass of hairy seeds that have the appearance of cotton-wool.

Dennis



SILVER AND GOLD

The left-hand picture shows the silvery buds that have earned for the sallow, in its earlier stages, the country name of "pussy willows." Several of the female flowers are shown also; their pale sage green colour is in direct contrast to the silver of the buds and the gold of the opened male flowers. In the right-hand photograph we see some of these male flowers in full bloom. Like the female, they come from silver-covered buds, but when they are opened their appearance is very different. The gold is chiefly due to the stamens, each of which has brilliant yellow-pollened anthers. It is the great masses of these stamens that constitute the Easter "palm," so popular as a decoration.

The fauna of the sallow is extensive. To begin with, it gives the lie to the popular notion that insects are not about until spring is well on her way and the full flowers of summer adorn the hedgerows and woodlands. Anyone who cares to visit a long hedge or clump of sallow when the "palm" is at its best cannot fail to be impressed by the numbers of bees that have come to the feast, filling the air with a dull, heavy humming, such as one is more entitled to expect when summer is at its height.

Not only bees of every sort, but spring beetles and moths and early butterflies are attracted in large numbers by the sallow, and the expert collector knows that his best chance of securing specimens of many of the rarer moths of spring is to visit the sallow hedge in the evening or at night when the weather is warm. To the botanist this fact is of interest, since the willows as a rule depend entirely on the wind for the purpose of fertilization; the sallow, however, offers a plentiful supply of nectar to the hungry insects, and when there are few flowers out in competition, it is sure to secure a good deal of attention.

As a food-plant, the sallow attracts many insects. One of the most notable is the lordly purple emperor, the finest and one of the scarcest of all our butterflies, while the emperor moth, the puss moth, and several of our rarest insects lay their eggs on the leaves or stems later in the year. There are also a number of leaf-galls that are found chiefly on the sallow, and several of our most interesting beetles feed on its leaves or within the rotting stems of the older trees.

Sallow's Secular Uses

To the woodman or forester the sallow has little value; it is cut for faggots in the hedgerows, where its pliant stems are especially useful for binding the bundles, and is of value for pea and bean sticks. The old-time herbalists believed in the healing powers of the bruised leaves when boiled in wine, and the green branches were thought to keep a room cool and fresh when the patient had fever. In modern times, however, the sallow is valued, and justifiably, purely as a decorative tree at a time when the world is still bare and grey with winter.

As the "palm" of Eastertide, adding its beauty to the seasonable decorations of countless homes and churches, it plays almost as important a part in the flora of the year as the holly and mistletoe of Christmas.

FRUIT OF THE SALLOW

When the days of "palm" are over, the sallow becomes for a while a wholly-insignificant bush, for the female flowers are anything but showy, and while the fruits are ripening there is little to attract attention. When they have ripened and burst, however, the fruit, surrounded by masses of hair like cotton-wool, will be highly conspicuous.

Dennis

SEAL DENIZENS OF OUR ROCKS AND SANDS

ALTHOUGH not many holiday-makers ever have the good fortune to spy a seal in its natural surroundings, there are many thousands of seals in British waters. Some dwell on the rocky shores of the Atlantic coast; others have their home on the stretches of sand that fringe the eastern counties. Both common and grey seals are described in this chapter

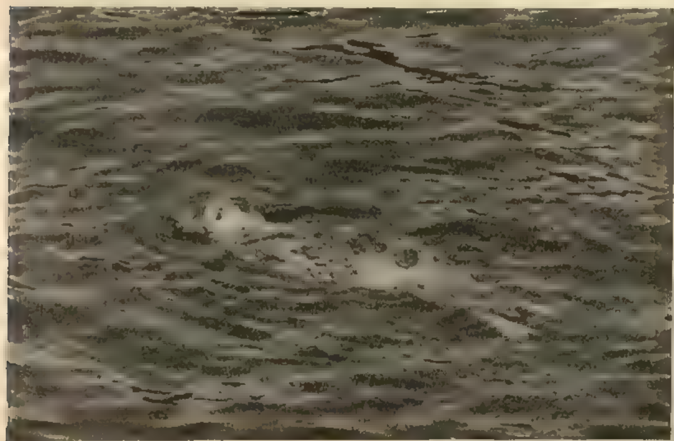
ALTHOUGH in imagination we may think of the various species of animals each and all striving for the prize of survival in life's race, it often happens that a species which has won its way and found a satisfactory position among the competitors may drop out of the race and, pausing by the wayside, find for itself a place of rest. This is what has happened with almost the entire family *Phocidae*, of which the seal is undoubtedly one of the most interesting members.

In the history of evolution, which is the story of the great race of life through the ages, we see how some of the fishes gradually left the waters of the ocean for the littoral life upon the seashore and became half aquatic and half land-living animals. As the tale goes on we see how these amphibious creatures found for themselves homes farther inland and eventually forsook the water altogether, leaving their less adventurous cousins behind them. Some of these new land-dwellers burrowed into the ground; some of them took wing and flew through the air, alighting and nesting in the trees; and others roamed the surface of the land and found a livelihood in the vegetation and animal life which gave them nourishment.

It was at this stage, we may presume, that the distant forefathers of the seals, roaming over the countryside many millions of years ago, found it impossible to discover for themselves among the hordes of other animals a safe habitat for their species. They had already advanced so far that they suckled their young and could now, in scientific terminology, be known as mammals. There were mammals everywhere, however—swinging from the branches of the trees and perhaps building small houses for themselves, roaming through the forests and burrowing into the ground. The banks of the rivers were occupied no less than the tops of the mountains. There was no home for the seals' forefathers, and the only alternative to finding a home was to become extinct.

PAUSING for a moment, one can almost picture the seals deliberately deciding to seek safety in a marine habitat. It is more reasonable to assume, however, that the process was quite instinctive. Those seals—or forefathers of the seals—which lived far inland did become extinct, except in rare cases, while those which lived near the coast found there was much less danger if they remained near the water, and, learning to swim, hunted for their livelihood in the depths off-shore.

In this way, while the race still went on and myriads of other species were developing and changing and dying



Frances Pitt

AT HOME IN THE WATER

In his adopted element the seal is a master of the art of swimming both on the surface and under it. The upper picture shows a young seal swimming happily towards its mother who is waiting on a nearby rock, while the lower gives an impression of the baby seal keeping itself on the move with its fin-like flippers, and peering about under water in search of possible prey.

out, the seals remained, although mammals and sucklers of their young, for all essential purposes nothing more than fish They lived their lives entirely in the water, except for a brief sojourn on land when the sun was warm, and during the breeding season ; for although they adapted their lives to the new environment in practically everything else, they were unable to change their old breeding habits and the males would seek for their loves not in the water, but on the shore. Fish and sea-birds became their diet, and as time went on their bodies, like their habits, were adapted to the new way of living. Owing to the low temperature of the water those seals which—perhaps quite by accident—were not born with more fat beneath their skins than is usual with most animals, died—one might almost say, " from exposure "—and gradually, as descendants of the better-covered members of the family, there evolved a race of seals whose blubber lay inches thick under their sleek skins.

PREPARING TO PLUNGE

With its head just raised above the surface, the seal seen below is preparing to dive into the depths. While it makes use of its front flippers and its tail in keeping afloat, the layer of blubber under the skin does much to make swimming an easy matter.

Frances Pitt

Thus protected from the cold, they were better suited for the task of adapting themselves to marine conditions. Their bodies became much more torpedo-shaped ; their lungs expanded enormously, so that they could hold their breath for a long time under water ; and their limbs, intended for walking on land, became gradually changed into swimming flappers. Their hind limbs, in

Seton Gordon

WHITE-FURRED BABE

Here we see a baby grey seal basking on the rocks above the water's edge and watching with wide-eyed astonishment the antics of its parents. Although it appears to have already been in the water, it still retains the early coat of white fur which it will continue to wear for some weeks to come.

fact, in the course of time, atrophied and became fused in the upper part, so as to form an almost fish-like albeit horizontal flapper or tail. They became the seals as we can see them today, not only in the Arctic and Antarctic, but also round the coasts of Britain

There are two principal types of seal which may be found in this country—the grey seal, of which there are large numbers, and the ineptly named " common seal," which is much less familiar. Off the west coast of Scotland, in Ireland, in the Scilly Islands, off the coast of Cornwall, grey seals occur literally in thousands.

Seals of the Sandy Shores

THE common seal usually prefers a less wild and rocky habitat. On the east coast of England, where the low-lying shores produce wide sand bars, this species is found. At Blakeney, where the National Trust is preserving the wild life of this kind of habitat, isolated seals may be seen at low tide, black, slug-like forms lying on the shining sands. It is extremely difficult in such a region as this to get near these animals, for there is no cover. As soon as they are disturbed they raise themselves on their flippers and with extraordinarily agile movements shuffle back into the waves. Once in their adopted environment they are soon lost, for, diving beneath the surface, they can swim for many hundred yards before they need rise again to take a " breather."

Berridge

SEAL ROUNDHEADS

The so-called common seal (actually no commoner in Britain than the grey variety) is found mostly on the east coast of England, particularly on the sand banks of the Wash and north Norfolk. Considerably smaller than the grey seal, it has a rounder skull with a much more prominent forehead.

During the wild and stormy early autumn, when the equinoctial gales drive the great Atlantic rollers against the rocky cliffs of the west, the males of the grey seals fight with one another for their mates. One male, if he is strong enough, may collect a whole "harem" and, herding his ladies on to an isolated rock, stand in defence of them against all comers. At this season, while the storms are at their greatest, the seals have no need to worry about attack from any of their enemies. To Man they are practically inaccessible, unless shot at with a long-distance rifle from some fairly large boat.

Teaching the Babies to Swim

In October the females resort to the beaches and high cliffs and find hiding places in deep caves, where they may give birth to their single young ones. The offspring, which are born covered with fur, remain above the tide line for several weeks before the mother allows them to venture forth into the water. An interesting proof of the land-living origin of the seal is to be found in the fact that, unlike true water-living animals, baby seals have to be taught to swim by their mothers. In a calm pool sheltered from the roaring breakers the mother seal allows her young ones to enter the water only after numerous demonstrations of exactly "how it's done."

The mother or dam suckles her young one until it has lost its birthday coat, which is of long white fur. As time goes on this changes to a dappled brown, and after about the sixth week the second coat is perfect and of the same grey-brown coloration as the mother's. Since the early part of the life of the young seal is always spent in the wild winter months, very little is known by naturalists of its domestic and family affairs. Watchers have, of course, seen much, and some of our enterprising scientists have spent months on end investigating the habits of these animals; but we can by no means assume that they have observed everything, or that the behaviour of seals in captivity is anything like the normal.

Still less, however, is known of the private lives of the other British species, and it is mostly by hearsay from old fishermen and other not entirely reliable observers that the common seal is stated to bear its young upon the open sandbanks and beaches, where the species is usually observed. It is said that the newly-born seals swim almost immediately after taking their first meal, and if it is true that they are born on flat, tidal sandbanks, this must be the case, for if they were not able to swim by the time the tide came in, it is clear that they would be drowned.

The seal is one of our most beautiful and graceful animals, both on land and in the water, and it is more than fascinating to watch several seals at play. They have extraordinarily beautiful, brown, almost pathetic eyes, and the mother's nearly human maternal instincts cannot fail to appeal to all.

Yet in spite of its attractiveness as an animal and its position in evolutionary history, much has been done in late years towards exterminating the seal. Fishermen, believing that the seals ate the fish by which they gained their livelihood, complained to the Ministry of Agriculture and Fisheries and a special licence was granted for the killing off of both species in all districts. True, a considerable amount of opposition and controversy was raised by this action, not only in the press, but also in the House of Commons, but before anything could be done more than 120 seals had been shot or clubbed to death. It was pointed out by numerous writers on natural history subjects and many other lovers of Nature that the Plymouth Marine Research Laboratory had carried out extensive researches into the diet of seals and had found no incriminating evidence by which they might be charged with destroying the shoals of fish through which the fishermen get their living.

Further evidence for the defence has now been brought to light by the well-known Scillonian naturalist, Mr. C. J. King, who points out that he has rarely, if ever, observed seals fishing near any shoal of marketable fish, but has, on the contrary, noticed these animals devouring numerous cuttle fish, which are themselves undoubtedly harmful to the fishing industry.

LIKE GIANT SLUGS

These grey seals on an islet off the Welsh coast are just near enough to the water for them to feel at home and far enough away to be in the warmth of the sun. At the slightest hint of the approach of an enemy, however, all five will rise on their flippers and with extraordinary agility spring back into the water.

Frances Pitt

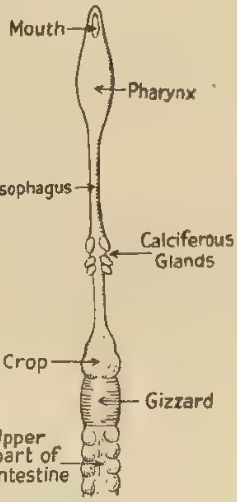
WRIGGLING REFINERS OF THE SOIL

KNOWN to everybody and despised by most, the lowly common or garden earthworm plays a tremendously important part in the preparation of the soil. Just how important is its rôle is explained in the chapter that follows, and the way in which it is performed is made manifest in fascinating detail

It is an extraordinary fact that a species of animal, the very name of which is synonymous with all that is lowly in the animal world, should have formed the subject for many great contributions to scientific literature, and should have taken up a large proportion of the time given to the investigation of Natural History by Charles Darwin, the most famous of naturalists.

The earthworm, small and insignificant animal though it is, plays an extremely important part in the geological drama of denudation and the natural tilling of the soil. Darwin's well-known work, which he entitled "The Formation of Vegetable Mould through the Action of Worms," was written only after many years of extremely careful and patient research, and to Darwin we owe almost our entire knowledge of the habits, life history and physiology of earthworms. Strange as it may seem, his book, although written nearly a century ago, contains a very large number of facts which are even today by no means common knowledge to the man in the street or the amateur naturalist.

MEMBERS of the division *Annelida*, or "ringed worms," the earthworms of Britain belong almost entirely to the family *Lumbricidae*. They are usually found to be about four inches in length, though it is interesting to note that in parts of Africa and India members of the same biological family have been discovered as long as four feet, and the "castings" left by these "beasts" on the surface of the soil are often some twelve to eighteen inches in height. Living in the soil, which it devours, an ordinary English earthworm passes more than ten tons of earth through its body in one year. This extraordinary fact, which was arrived at by Darwin through a systematic measurement of the weights of worm-casts, shows that the whole superficial bed of vegetable mould covering the ground passes through the bodies of worms at least once in the course of every few years. A layer of earth, one-fifth of an inch in thickness, is brought to the surface every year, thus bringing about continual change in the nature of the mould and perpetual exposure of the subsoil to the influence of the atmosphere.



WORM DETAILS
In this drawing the salient portions of the worm's alimentary canal are plainly marked.

THESE movements of the soil are, of course, of extreme importance to the plants which grow in it, and to the maintenance of fertile grass lands and downs where cattle and sheep are reared and bred. Apart, however, from the practical side of Darwin's investigations, vastly important though that has proved to be, the academic interest which they aroused set the scientific world thinking in new directions and opened up many new and fascinating lines for research.

PHYSIOLOGICALLY the British earthworm *lumbricus* is divided into about 200 ringed sections. The second section contains the sucker-like mouth, which is protected by a sensitive palp of flesh projecting in front of it from the underside of the first section. It is by means of this sensitive protrusion that the worm is able to feel its way through the soil and to gain some knowledge of its surroundings when on the surface. Each section is provided with four minute bristles, or *chaetae*, which can be controlled by means of muscles. With the aid of these elementary limbs and by muscular movements of the body the worm propels itself through the soil, taking the earth into its mouth at one end and passing it through the simple alimentary canal to the other. Having no eyes, the earthworm must rely almost entirely upon its sense of touch; and although it can feel vibrations both in the ground and in water, it is unable to appreciate the movements of the air to which we give the name of sound.

Provided with a large muscular pharynx just inside the mouth, with an oesophagus or gullet on which are to be found a number of calciferous (lime-bearing) glands (whose functions are even today a matter for conjecture), and with a very strong crop and gizzard where the entire process of digestion takes place and every morsel of nourishment is extracted from the soil, the worm lives upon the decayed vegetable matter or humus which is passed into its body. From the types of soil in which worms are usually found it would appear that the fresher the humus the more they appreciate it, and Darwin was able to show that, contrary to popular superstition, they prefer animal flesh when it is fresh and will often not touch it if it is putrid. They make very little use, if any at all, of the natural, inorganic salts also to be found in the soil, and the action of the calciferous glands has been partially explained by some scientists who put forward the theory that they are used as a reservoir in which to collect any superabundance of lime.

On dissection of the gizzard of an earthworm a number of tiny pebbles are invariably found, well-polished and with their corners rubbed off, showing that they have been ground together for quite a considerable time. It

has been suggested that, like birds, worms make use of grit and small stones for grinding their food and preparing it for the process of digestion.

Terrestrial animals though they are, worms are in a sense semi-aquatic, like the majority of the annelids. If exposed to the dry air of a well-heated room they are liable to die within twelve hours, while, on the other hand, M. Perrier, a French scientist known to Darwin, managed to keep a worm alive and submerged in water for four months. In their natural state they invariably find their way into damp soil, and during the dry months of summer or

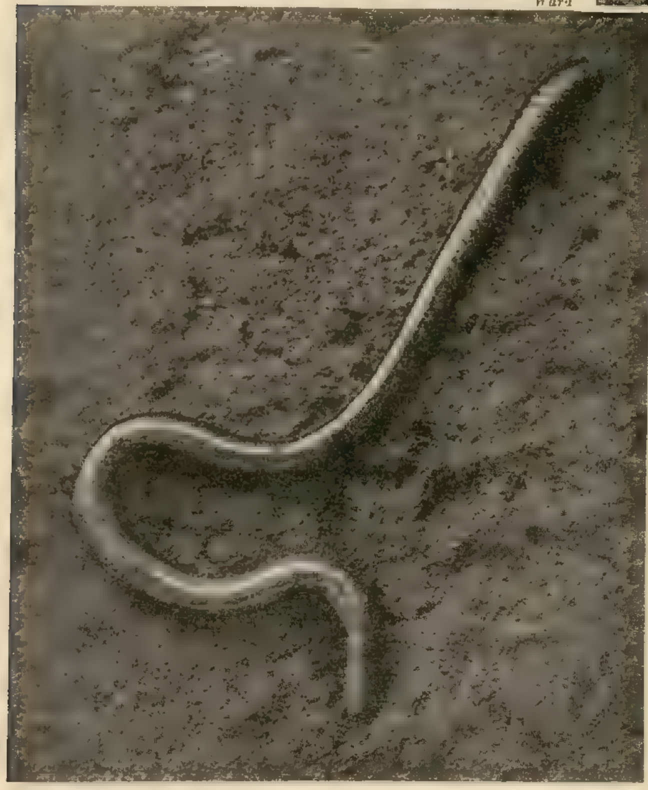
TONS PER ANNUM

Earthworms live upon decayed vegetable matter or humus contained in the soil, and in the process of extracting its nourishment a worm "eats" many tons of earth in the course of a year. The rejected matter is excreted in powdered form, constituting the familiar casts found on the surface at the exit of a worm-burrow.

GOING UNDERGROUND

Below we see a common earthworm in the act of burrowing into the soil. In loose soil this is done by pushing aside the earth particles with the "head," but in stony or hard ground the worm eats its way.

Ward



the period of winter when the ground is frozen they cease their labours of burrowing, and lie still in their holes well below the surface.

The popular German name for the earth worm, *Regenwurm* (rain worm), gives some indication of the fact that worms come to the surface and are seen only when the ground is damp, though Darwin, ignoring the deposition of dew at night time, endeavoured to explain the fact that worms are nocturnal in their habits by claiming that they are sensitive to light. It is true enough that by means of the central nerve ganglion in the head or anterior end the earthworm is conscious of any violent change in light intensity, but slight variations undoubtedly pass unobserved. A very small change, however, in the humidity of the atmosphere will cause them to leave or retire to their holes as the case may be.

It is a curious fact that after a day or so of heavy rain an astonishing number of dead worms are often seen lying about on the ground. If a worm can be kept in captivity for four months under water, it is clear that those seen on the surface after a rain storm cannot have been drowned, and Darwin attempted to explain this mortality by suggesting that the victims were already diseased and that their deaths were really hastened by the rain causing them to leave their burrows for the cold air of the surface.

Under normal conditions, however, a worm emerges from its hole at night and, lying with its tail just within the mouth of the burrow, feels around it for the remains of both animal and vegetable life which it devours. When frightened by vibrations caused by approaching footsteps, it hurries back into its hole, and with a quick movement of the tail pulls itself out of sight.

NOTES ON WORM-WATCHING

The observation of the movements and behaviour of worms, although it does not sound a particularly absorbing pastime, can be literally fascinating once an interest in these creatures has been aroused. A wide expanse of well-mown lawn is undoubtedly the best place to look for them, and here, some two hours after sunset, they may be seen crawling out of their holes or throwing up the little piles of casts which are such a nuisance to the gardener. A well shaded lantern or electric torch does not frighten them away, for the light is not strong enough to penetrate their skins and to affect the central nerve ganglia in the head. Great care must be taken not to move too quickly over the grass, for the vibrations caused by this will be felt almost at once by the worms, which will immediately vanish underground. If these precautions are taken there is no reason why the numerous earthworms which come out and crawl about on the lawn during the hours of darkness should not be watched until the observer has seen all that is of interest to him.

Darwin's Study Method

In order to keep worms in captivity, flower-pots filled with earth should be used. If the pot is left standing in a saucer of water and a plate of glass placed over the top, both the soil and the air above it will be kept at the right degree of humidity, and the worms will be able to live a normal existence. This was the method employed by Darwin himself, and it has the great advantage over all other methods that experiments with the effects of different soils on worms, and worms on soils, can be carried out simply and efficiently.

VIOLETS OF VARIED HUE AND HABIT

EVERY rambling naturalist experiences a thrill of pleasure when he glimpses, half-hidden amid the undergrowth of the ditch-banks or woodlands the delicate flowerets of the violet. The principal species of the plant are described below, and the varied methods of propagation are explained in detail

DEMUREST and best loved, perhaps, of all our flowers, the violet is as well known to the town-dweller as to the countryman, for it is one of the few wild flowers that is really popular with both gardener and professional horticulturist. It is chiefly prized for its scent, but its peculiar quiet beauty has a different appeal, and these features have combined to make it a universal favourite for many years.

These remarks apply to the sweet violet, which is the variety that is so well known in its cultivated form. There are, however, several other species found wild in the British Isles, which are scarcely less attractive and ornamental. Many a rambler must have picked a bunch of wild violets, only to discover too late that they are scentless. In spite of superficial points of similarity there are a good many points of difference between our native species, and some idea of how to distinguish them may be appreciated.

Of our six native species, one is very rare, and two others have been divided by botanists into several sub-species. One of these is the pansy or heartsease, the wild stock from which our garden violas and pansies are raised, and a plant which will be dealt with in a later chapter. The others are, besides the sweet violet, the dog violet and its sub-species the wood violet; the marsh violet; the hairy violet; and the very rare and local sand violet. All these have the common character of the typical "pansy-shaped" flower, in which there are five petals and the flower-stalk bends over in such a way that those petals which appear as the upper ones are really the lower. The two petals that are seen at the top are narrow, and stand upright, bend forwards or curl backwards, while the odd petal is broader than the rest and has a whitish patch at its base; at the back it is prolonged into a short, blunt spur. The heart-shaped leaves, like the flowers, are borne singly on long stalks.

The sweet violet has, typically, a deep reddish-purple flower, but examples may be found in the course of a single walk varying from deep blue to pure white. The leaves are smooth and shining when they first appear, but later they become covered with fine down; their margins are serrate. The stem of the plant is thickish and very short, so that flower-stalks and leaves appear to arise direct from the rootstock.

FRAGRANT FLOWERETS

A favourite garden flower, the sweet violet is also one of the most popular members of our wild flora. Here a bunch is seen growing on a woodland bank, against a background of ivy and arum leaves. Notice the way in which the stems turn over above the flowers; the shape of the leaves, with their serrated edges; the curved horn at the back of the flower; and the dark veins on the lip-petal.

Dennis

Peculiarities of Violet Propagation

THE methods of propagation of the violets provide the botanist with a most interesting series of problems. If we examine a flower closely we find that the anthers unite to form a tube, the top of which is the bright orange body that is so conspicuous an object in the centre of the flower. Through this tube projects the stigma, borne on a long style and, owing to the reversal of the flower already mentioned, pointing in a downwards direction. If we were to cut the flower in section, we should find, of course, that the style was in the centre of a ring of stamens, which are close enough together to form a little chamber; two of the stamens, moreover, send fine tails backwards into the spur that is formed by the median petal; at the tips of these tails there are honey-glands.

The working of this complicated arrangement is evident when a bee visits the flower. The insect alights, naturally, on the single petal, and attempts to reach the nectar which is secreted at the back of the spur. The stigma, however, prevents the bee from simply slipping its tongue in, and it is, therefore, compelled to force the entrance, using its large and furry head to push the stigma aside; this action disturbs the pollen on the anthers, and some of it drops out on to the bee's head. In this way the pollen will be on its head when it is used to push aside the stigma of another flower. Since the stigma is sticky, it will pick up the pollen, and fertilization is ensured. Thus we have yet another example—very different from that in the primrose and the arum, which were dealt with in former chapters—of the various means employed by Nature to achieve the same end, namely cross-fertilization.

BUT the violet is not entirely satisfied with this one method of securing propagation. When the showy flowers which delight us in the hedge banks in April and May have died down, a new series of what may be called "blind" flowers arises, devoid of petals or of any attractive

Bedford

IN THE MOIST SHADE

The marsh violet, shown in this fine photograph, is one of our lesser-known species, but by common consent one of the loveliest. Growing here among bluebell plants, it displays a marked preference for damp woods. The smooth, rather shiny leaves, and paler flowers with a strongly-marked lower petal, distinguish the marsh violet from any of the other species found in Britain.

organs, and consisting, so far as we can see, of simple, green buds. These flowers have no long stalks, but are to be found hidden deep down among the bases of the leaf stalks and the old flower stalks; they possess, in fact, the quality of modesty which the poets have erroneously attributed to the more showy true flowers of the violet. If one of these green buds is cut open, it is found to consist simply of a series of stamens, and an ovary which bears a stigma direct on its surface. Within the bud these stamens drop their pollen on to the waiting stigma, and fertilization is virtually assured. Some months later the stalks bearing these buds lengthen, the swollen ovary splits and displays itself full of neat little black seeds, and the flowers of spring are credited, by the unknowing passer-by, with the fruit that was produced long after they had died.

It would seem, however, that even this system is not infallible, for Nature has provided yet another means of reproduction for the violet. This is in the form of long, thin, tough runners, which spring from the base of the stem and shoot out over the surface of the soil, sending down rootlets from time to time, and finally terminating in a new little plant at some distance from the parent. This form of vegetative reproduction is familiar to every gardener who has ever increased his strawberry plants.

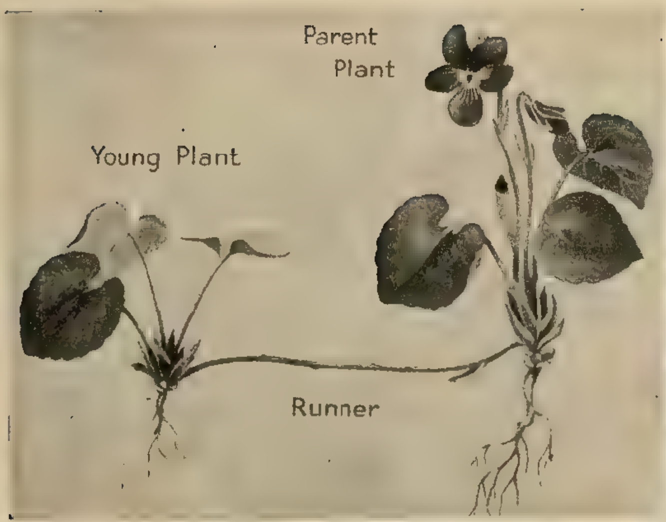
THE presence of these three types of reproduction in the one plant is interesting to anyone who would seek cause and effect, for in Nature we seldom, if ever, find that any system is maintained that is of no value. The reason for the need of extra methods of reproduction is not far to seek. Not only does the violet flower in most years some time before there are many bees or flies about which are likely to visit its blossoms, but even when they do fall to the attractions of the purple blooms, there are many whose tongues are not long enough to enable them to reach the inside of the flowers. The bee for whom the flowers are best suited, it is interesting to note, is the little *Anthophora* which is described in Chapter 3 of The Wonders of Insect Life (page 155). This bee has a tongue many times longer than that of the honey-bee, and is one of the earliest bees to be on the wing in the springtime; but at the same time it is local in its distribution and confined to certain types of landscape and scenery, and thus is often in a district quite unsuited to the violet plant.

EQUALLY with the pansy, the commonest of our violets is the dog violet, a plant distinguished by its lack of scent. It is probably this plant that actually gives most pleasure to the rambler, for it is very widely spread throughout the country, and often grows in such profusion as to form a blaze of pale purple on the green turf. The flowers are paler in colour, less bold, rather more delicate than those of the sweet variety, but they last over a much longer period. There is a distinct stem

SCENTLESS BEAUTY

Commonest of our wild violets, the dog violet is distinguished by its lack of scent. The background of this picture gives a suggestion of the type of situation which the plant prefers, a grassy common or the stony slope of a downland valley. The broader, more open flowers, and narrower, more pointed leaves, also serve to distinguish the dog violet from the sweet species.

Dennis



Ward

VIOLET PROPAGATION BY RUNNERS AND 'BLIND' FLOWERS

The sweet violet has three methods of ensuring the continuation of its race. The normal method of plant propagation is by flowers, but these are practically useless in the case of the sweet violet. Two alternative methods have been evolved, of which the first, known as vegetative reproduction, is shown in the diagram above (left). Runners from the main rootstock produce new young plants at their ends, and these in turn send out other similar runners. The second alternative method is by insignificant little green flowers (known as "blind" flowers), produced in summer deep down among the leaves, and giving rise to the seed-pods shown in the right-hand photograph

which rises upwards, bearing leaves and flowers, both of which have quite long stalks; the leaves do not enlarge after the flowering period, and the plant is never hairy.

The sub-species known as the wood violet differs in having a short rootstock like that of the sweet violet, instead of an ascending stalk. Branches are, however, given off all round the rootstock, so that what appear to be several plants may in fact be only one. This plant, as its name implies, is found chiefly in woods, and it is possible that its characteristic manner of growth is merely an adaptation to a different situation; the upright stem is obviously needed in thick vegetation, whereas the creeping stem is admirably adapted to the leafy ground beneath trees.

The hairy violet is a plant of the chalk downs; its flowers are rather darker than those of the dog violet, and the whole plant is covered with down similar to that which clothes the sweet violet later in the season. This plant is unmistakable; it is the most nearly related to the sweet violet, for its leaves enlarge after the flowers have gone, and there is sometimes a slight scent noticeable.

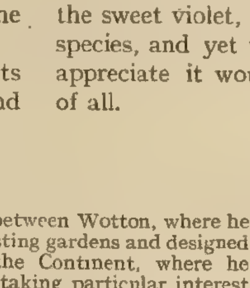
THE marsh violet is another very distinct species. It is found every wherein damp places, whether in the open or under trees, preferring thoroughly sodden ground. The flowers are of a pale lilac colour, with conspicuous dark veins, and the leaves, which enlarge later in the season, are smooth. Though far more widely distributed than the sweet violet, it is the least known of all our common species, and yet those who have learnt to recognize and appreciate it would, perhaps, claim it as the prettiest of all.

Revealers of Nature. 4

JOHN EVELYN

THE descriptions of "country gentleman" and "man of letters" are eminently suitable to John Evelyn, who, although a very minor figure in English literature, and probably unknown to most people, possessed exactly the mental width and impartiality connoted by the latter, and the calm, pious, and perhaps supercilious temperament implied by the former designation. With the exception of his Diary, which is infinitely less famous and popular than that of his contemporary and friend, Pepys, his works are largely forgotten, yet in a variety of little books and essays he shows himself at least as pleasant a character as Izaak Walton, whose interest in and love of Nature he shared. But whereas Walton was obviously a lover of the open spaces, Evelyn possessed a mind which took its greatest pleasure within the limits of a walled garden (although, as his famous "Sylva" shows, he had a keen eye for a beautiful tree); he became, indeed, the most famous designer of gardens and garden architecture of his age.

John Evelyn was born at Wotton, Surrey, on October 31, 1620. Though loyal to the king and an ardent churchman, he did not take up arms in the Civil War, but divided his time between Wotton, where he beautified the existing gardens and designed new ones, and the Continent, where he travelled widely, taking particular interest in the scenery. In 1652 he purchased Sayes Court, Deptford, where, again, he proved a brilliant horticulturist, his gardens there and at Wotton becoming quite famous. One of the original members of the Royal Society, he was friendly with most of the men of genius of his day, but spent the greater part of his time quietly in the country, dying at Wotton on February 27, 1706.



Evelyn's link with two of the great figures of his age is amusing. He let Sayes Court to Admiral Benbow in 1696, and two years later the admiral sub-let the place to the Tsar, Peter the Great. The latter's tenancy brought havoc to the famous gardens, for the Tsar took great pleasure in wheelbarrow rides, careering through hedges and over flowers, and doing such damage throughout Evelyn's carefully planned domain that he was mulcted of about £162 by the outraged diarist.

Ugliness or destruction of any kind was anathema to Evelyn, and one of his most interesting works was his "Fumifugium," a protest against the damage wrought by coal-smoke in London, and a plea for beautifying the suburbs with flower-beds. But his best-known publication was his "Sylva," a beautifully written discourse on forest trees and the propagation of timber, and an argument for re-afforestation. The pleasant woods of Surrey were a source of great joy to Evelyn, and in the style of "Sylva" can be seen the quietening effect of Nature on a mind which could be roused to fury by the "hellish and dismal cloude of sea-coale." His "Pomona" concerns fruit-trees and their relation to cider; while among Evelyn's other works on Nature are his "Kalendarium Hortense," "A Philosophical Discourse of Earth" and "Terra." He also published translations from the French of "The Compleat Gardener" and "Of Gardens." These works, and especially "Sylva," which is an excellent example of beautiful prose at its best, besides being of extreme interest regarding the distribution and growth of trees, deserve to be more widely known.

THE FASCINATING STORY OF THE FROG

THE life history of the frog comes as a matter of course within the purview of every student of biology, for the little amphibian is a link between the reptiles and the fishes, and its mode of development throws much light upon the probable course of animal evolution. Below, the stages in the process are revealed in picture and story, and the two species of frogs found in the British Isles are compared

THE frog is a very good example of that class of organisms known to scientists as *Batrachia* (Gr. *batrachos*, frog), that is, animals which begin life at a very low stage of development and pass through a fish-like larval stage before attaining to any likeness of their parents. Reptiles (snakes, lizards, etc.) manage to get through this larval stage while they are still enclosed within the egg or the parent, and they never find it necessary to grow water-breathing organs, or " gills " as they are called. The batrachians, sometimes known as amphibians (Gr. *amphibios*, leading a double life) because they can live both on land and in the water, are clothed with a soft skin, and are not protected, as are the fishes and the reptiles, by scales or armour plates. The skin of the amphibian, in fact, acts to a certain degree as an extra portion of lung tissue, for, through intimate contact with the air, the blood, which flows very near the surface of the skin, is able to absorb oxygen and to go through the same process of vitalization as that which takes place to a greater extent in the lungs. The frogs, toads and newts are a class of animals intermediate between the fishes and the reptiles in the history of evolution.

Nearly two hundred species are included in the family of true frogs or *Ranidae*, but only two are commonly found in the British Isles. The first of these is the common brown frog (*Rana temporaria*), which is to be encountered in large numbers in most parts of England, Scotland and Wales, but only locally in Ireland. The second species is the green or edible frog (*Rana esculenta*) which is found mainly in the eastern counties of England, and which is supposed to have been introduced from the Continent, perhaps during the Roman occupation in the opening centuries of our era. *Rana esculenta* is usually larger than the common frog and has a more mottled appearance and a distinct fold along each side of the body. Furthermore, the males have conspicuous round sacs on each side of the head which are considerably distended in the act of croaking.

MANY of us, no doubt, have at one time or another collected the slimy " frog spawn," as the jellied mass containing the eggs is called, and kept it at home in a roughly constructed aquarium in order to watch from the beginning the extraordinary process of natural development. Frogs pair in the very early spring if the weather happens to be warm and mild, and later if frost covers the ponds and streams with a layer of ice. Crawling from

SPAWNING IN THE SUN

Basking in the sunlit waters of the pool and clinging to the water-weed beneath them for support, these frogs are spawning in luxurious ease. At this stage the eggs have only just been fertilized by the male frogs, and appear as tiny spheres, half black, half brown, contained within the mass of jelly.

Roberts

M. H. Crawford

OPENING CHAPTERS IN THE FROG'S LIFE STORY

Left to right, the first important stages in the development of the frog's egg. In the very early stage the eggs appear to the naked eye as nothing more than little balls, about $\frac{1}{10}$th of an inch in diameter, spaced regularly within the spawn-jelly. After a time, however, these little spheres change shape, gradually lengthen out, and become more tadpole-like in their appearance. In the picture on the right, what were once inert eggs have suddenly come to life as baby tadpoles, struggling violently in the effort to free themselves from the enshrouding jelly in which the first part of their existence has been so safely spent.

their places of hibernation, the creatures select their mates, serenading the objects of their attention with persistent croaking. It is a very interesting experience to watch a pool where frogs are in the process of mating. They will be seen all over the pool, clasped together in pairs, their heads just above water and the front legs of the female gripping a piece of pond weed or a drifting stick.

At the breeding time the male develops on the thumb of the right hand a special pad, which becomes swollen and black, and is made use of in holding the female. Such holding organs, not uncommon in the animal world, usually appear only during the period of sexual excitement, and are found only on the male.

Following the actual act of fertilization the eggs are deposited by the female at the bottom of the water in masses of several thousands. They are about a tenth of an inch in diameter, but the covering of the jelly-like substance binding them together absorbs so much water that they soon swell to as much as a third of an inch. Inside each of the tiny jelly spheres can be seen the black centre, which is the egg proper, with a minute white spot on the underside where the complex process of development has already begun to take place.

Specialization in the Tadpole

After dividing in half, and each half dividing again and again, the sphere of tissue so formed turning itself inside out, each of the individual cells of the developing larva begins to become specialized, and the formation of the spinal cord and the other parts of the body soon takes place. Within about three weeks, if the weather is warm and fine, the brown larvae, or tadpoles, appear within the body of the jelly, and remain clinging to it by means of the suckers on the underside of the head.

At this stage there is no indication of the presence of limbs of any kind, and the head, the body and the tail merge into one another after the manner of a fish. Even

JUST OUT OF THE EGG

Freed at last from the egg-covering and from the encumbering jelly of the spawn, these young tadpoles are resting quietly on a piece of water-weed, clinging to it by means of their sucker-like mouths. Quite a considerable time must elapse before they are able to swim about their natal pool.

Gaumont British

Roberts

TADPOLE INTO FROG

The gradual change from a tadpole to a baby frog is well illustrated in the above series of approximately natural-size photographs. First, the head of the tadpole swells considerably, and then change follows change in rapid succession. The legs appear while the tail is still attached, but this is soon absorbed

the gills are not yet present, but the small swellings on either side of the head give some indication of their existence. These "gill buds," as they are sometimes called, soon grow outwards and expand into the "gill-plumes," through which the blood of the tiny animal circulates freely, absorbing oxygen from the water and thus becoming purified. At first the mouth is not fully formed, but it soon develops, and the horny plates situated on the upper surface enable the tadpole to crop the pieces of soft vegetable matter upon which it lives until further change fits it for its future habitat.

In time the limbs begin to appear, all four growing at an equal rate, although the hind pair are actually seen first because the fore limbs are hidden in the early stage by the flap which originally covered the gills. At about this stage also the lungs begin to develop within the body, and the little animal changes from a water-breather to an air-breather in preparation for life on dry land.

THE outward appearance of the tadpole now soon changes to that of a frog, except for the fact that it still retains the long tail. This tail is not *shed*, as is often popularly believed, but is *absorbed* into the body of the young frog, getting smaller and smaller every day, until finally the hind part of the body is rounded off and the frog of about an inch in length comes into being.

What was undoubtedly one of the most interesting biological experiments of recent times was carried out by Mr. E. S. Goodrich, F.R.S., in 1918, when by a complicated process of dissection and extremely careful technique the unfertilized eggs of a frog were fertilized by means of the leucocytes, or white corpuscles, of the blood of the same frog. The "fatherless" frog which he produced in this manner was exhibited before the Linnean Society in November, 1918. This experiment shows what a small part the activity of the male frog plays in the actual production of offspring, and lately in many parts of the world scientists have claimed to have started the development of a frog's egg by means of minute free-living water organisms such as amoebae, as well as by pricking them with the end of a sterilized needle.

When Frogs "Fall from Heaven"

BY the time all the tadpoles in the pond have become real frogs and have developed their arms and legs sufficiently to enable them to swim, they fringe the edge of the pond and wait for the coming of a summer downpour before setting out on their first journey across country into the unknown. Immediately the rain begins to fall, they leave the water in thousands and make their way through the wet grass, turning their backs for ever on their native waters. Their movements are so quick and their advance is so sudden that many country folk swear that they have seen frogs fall from heaven with the raindrops, though the naturalist knows well enough that they have been in the pond all the time and have only forsaken the water for the dry land because of the storm.

IN ITS NEW SUIT

The little animal—half-tadpole, half-frog—shown in the picture below has just finished casting its skin, and sits basking in its newly-acquired clothes, while the cast-off garments lie discarded on the ground. This skin-shedding process takes place several times before the adult frog comes into being.

M. H. Crawford

height of several hundred feet above sea level in the very early spring. Usually frogs and toads do not come to lite and appear in the countryside until after the first two months of the year. Only by chance can we ever hope to come across these animals in winter, perhaps crowded together in a hidden group under the ground or at the end of an old drain, as much as two feet below the surface.

SOMETIMES they dive under the water of the pond, and, burrowing into the mud, find for themselves a sleeping place, though they are unable to spend the whole winter in this manner. Rubbish heaps, where their skins may be kept moist and in good condition, are also a favourite hiding-place, but with the

FROGS, 'EDIBLE' AND 'COMMON'

Two species of frog are found in the British Isles—*Rana esculenta* (above) and *Rana temporaria* (right), known as the edible and common respectively. The former is generally the larger, and has prominent round sacs beneath the ears and a fold along the side of its body.

For months they continue their journey onward, always separating farther and farther from their fellows, so that in the end they are distributed over a very large area of country. Their food consists mostly of slugs, worms, and insects of all kinds, the formation of the mouth making it possible for them to swallow fairly large prey without much difficulty.

DURING the winter months the batrachians, the group of animals to which, as was said at the beginning of this chapter, frogs are assigned, are slumbering away the time hidden in holes in the ground, under stones and ledges in earthy banks. Sometimes, however, they are seen abroad even in January if the winter has been very mild, and, floating down-stream or hopping slowly over the grass, they look somewhat out of place in the winter surroundings. In Devon and Cornwall frog spawn may be discovered as early as February, but this is very unusual. Some naturalists have even claimed to have found spawn in Wales at a

coming of severe frosts their legs and "arms" may freeze almost solid, and although they are not adversely affected unless their hearts are actually stopped, a cold winter will undoubtedly lead to the premature end of many amphibians which have not taken sufficient precautions against its icy grip.

HOW TO MAKE AN AQUARIUM

It is often extremely interesting not only to watch the wild life of pond and stream in its natural habitat, but to collect some of the many strange things to be discovered in the muddy depths and bring them home to an aquarium, where they may be studied more carefully and with greater ease.

Aquarium tanks may be purchased at animal dealers, but one of the large glass "baths" used by electrical companies for the transport of acid, or one of the cells which hold the acid round the electrodes of the batteries will do just as well, and will probably prove less expensive. These tanks are some three feet long, two feet wide, and about one and a half feet in depth, and are made of solid glass. A home-made aquarium can, of course, be constructed from sheet zinc, plate glass, and cement, but if one of these glass "baths" can be obtained it can hardly be bettered for the purpose.

The tank should be mounted on two wooden blocks, shaped to hold it a few inches above the ground and fixed in such a way that the tank cannot be tipped over or upset easily. Before placing the tank in position its bottom must be painted on the outside with a thick layer of dark-coloured paint, in order that no light may reach the pond life in the tank from below. If any light should so reach them, the animals and plants will suffer strange changes of coloration, and often of shape and general development.

Choosing a Site

In selecting a site for the aquarium, it must be kept in mind that very bright light, particularly direct sunlight, is not good for underwater life, and that a shady spot should always be chosen in preference to one where there is less protection from the sun.

Once the tank is fixed in position and has been filled with water for the first time, the problem of keeping the water well charged with oxygen has to be faced. Water-weeds of all kinds are, of course, a great help, for, like any other plants, they give off oxygen and absorb carbon dioxide, thus keeping the water fresh and clean. If possible, however, a jet of running water should be directed into the tank at least three times a day, and allowed to flow for about ten minutes at a time. In this way bubbles of air are driven below the surface, and large quantities of oxygen are dissolved.

Electrically-driven agitators can be purchased for re-aerating the water, but great care must be taken to ensure that they are properly insulated.

THE GROWTH OF A GRAIN OF WHEAT

MOST important of the cereal foods of Mankind, wheat has been cultivated in Britain since before history began, and despite foreign corn imports is still one of the most important crops of our countryside. Below is told the story, so far, at least, as it is understood, of the germination of the wheat grain

IN the early springtime the ploughed fields become covered with a beautiful carpet of deep green corn, as the grains planted in the autumn a few months before germinate into life and push their way to the surface of the ground into which they have been washed by the rains of winter. There are few sights more lovely than a wide field of young corn shoots, which present, as the wind blows across them, moving waves of lighter and darker shades of green stretching away into the distance. But what is happening under the ground to produce such a carpet of waving green blades on the surface of the soil, which so recently was ploughed and harrowed until not a single vestige of green showed as far as the eye could see?

THERE is something within the grains of wheat which, as soon as the weather begins to get warmer and the sun starts to shine a little more, makes them spring into being and thrust upwards with their shoots towards the light, and downwards with their roots towards the salts in the soil. This something we term life, the ever-present and as yet unsolved mystery of the universe. Although it is only a comparatively simple form of life, the grain of wheat presents just as baffling a problem as the behaviour, say, of a skilled athlete or of a great mathematician. For while we know that these examples of the human kind have brains and muscles supplied with nerves with which to control their behaviour, there is practically nothing to explain the apparently thought-out actions on the part of the growing root or stem of the young plant. It is possible, of course, that these actions and movements, which appear at first sight to be dependent upon some form of intelligence, are forced upon the plant by the surrounding conditions.

Thus, if a growing root tip is forcing its way into the ground it may come across a stone, through which it is unable to penetrate, and, therefore, becomes diverted in its course. On the other hand, if a grain is planted in very soft soil, before it has grown to any great height many more roots will have appeared to hold it firmly in the soil than will be found on another grain which is planted in firmer ground, where it would not be so difficult for it to remain in an upright position. While growing, it seems that some governing factor in the plant itself must decide that more roots are required at the base, and it is examples of such extraordinary, apparently premeditated and controlled behaviour as this that go to make the whole problem of life so inexplicable.

Bastin

STAFF OF LIFE

Two well-developed and fully mature ears of wheat. Thousands of such ears go to make up a field, and owing to the fortuitous circumstances of the plant's growth no two can be said to be exactly similar.

BUT if we are unable to explain the theory of how a grain of wheat grows, we can at least trace the history of what actually takes place, for only by careful observation, by the keeping of records, and, above all, by patience has anything ever been discovered or finally explained in the world of science.

On examination of a single grain, taken either from the top of a sack or directly from a ripened ear, we see that the spindle-shaped seed has a cleft, or channel, running down the side, and a tuft of silvery hairs at one end. As soon as the grain is exposed to moisture it swells, until all the little wrinkles have been smoothed away. The hairy end still remains the same, but at the other extremity a small hump appears; beneath this lies the tiny embryo, from which in course of time the stem and roots of the wheat plant will spring into life. From one side of the hump the *plumule*, or young shoot, will appear, while from the other side the *radicle*, or young root, will slowly push itself downwards into the soil.

ON the other side of the grain, among the tuft of hairs, it is possible to discover the origin of the channe running from one end to the other. This channel is nothing more or less than an irrigation canal, and the hairs are so situated at the end that any water they may collect from the soil is at once conveyed by capillary attraction to the other end, where the plumule and the radicle are both in need of all possible moisture which is to be found between the particles of the soil and which contains in solution the salts necessary for growth.

Now why is it that the grain of wheat has formed such a good basis for food? Solely because it is composed, for the most part, of a store of nourishment destined to support the young plant before the mechanism of the roots and the leaves has come properly into action. This store is made up of a substance called albumen, and is quite distinct from the embryo itself, wh ch is composed of the radicle and the plumule. This store

Tattersall

SOWING BY HAND AND MACHINE

The left-hand picture shows the old-fashioned way of planting wheat, i.e. scattering it on the ground by hand. The photograph was taken in the Isle of Arran, where many of the old-time rural customs are still practised much as they were in Biblical times. The right-hand picture, however, shows the march of time in the world of agriculture, for here a modern planting or "drilling" machine, though not tractor-driven, is doing the work of many hand-sowers—and performing it, it need hardly be said, much more efficiently.

of food may be compared to the yolk of the chicken's egg, which serves as food for the developing chick-embryo.

The conditions required before wheat will begin to germinate are moisture, warmth and the presence of oxygen. The ground has been ploughed and the under-surface exposed to the air, which contains oxygen and remains in the crevices formed between the particles of soi surrounding the grain. Moisture can be obtained both from the air and from the soil. The scientific investigator Sach showed that wheat begins to germinate below 5 degrees Centigrade (about 40° F.), but while actual germination may begin at this temperature, growth will in all probability come to nothing unless the temperature rises very considerably.

About the second day after planting in most soil the skin over the embryo breaks and leaves a slit reaching from end to end of the hump. On the third day there appears in the middle of this slit a white spot, which, as time goes on, gradually breaks through as the tip of the radicle still enclosed in its sheath. On the fifth day the whole of the sheath is exposed to view, the outer skin having been forced aside, while the tips of both young root and young shoot are coming to light at the ends.

At this time it may be noticed that the plumule is somewhat more advanced in growth than the radicle, but this gain is very short-lived, for soon afterwards the root begins to grow much quicker than the plumule, as if the plant realized the necessity of roots before a firm enough grip can be obtained in the soil for the plant to bear the weight of the growing shoot. While on the sixth day the shoot has hardly advanced in growth at all, the root has lengthened very considerably, and, further, two more swellings can be seen at the base. On the seventh day these are revealed as two more roots, which botanists call adventitious roots.

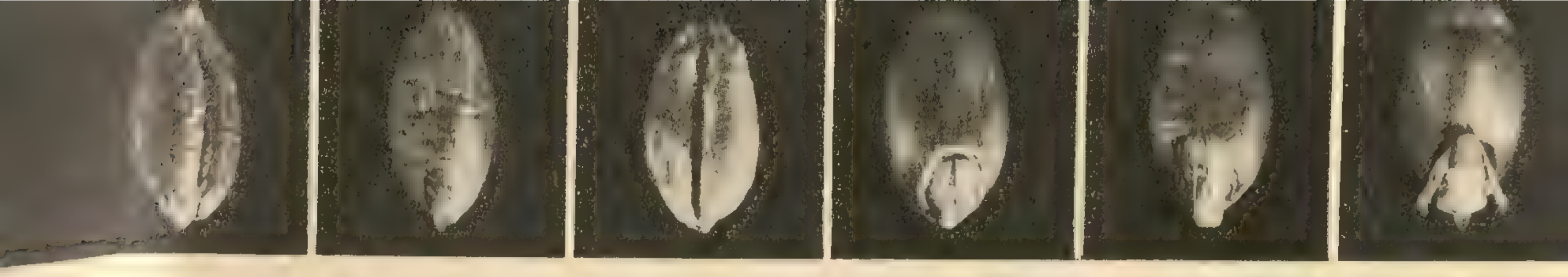
The root tip is gifted with wonderful powers of selection, for not only can it find its way round the various stones which it encounters, but the fine hairs with which it is covered are capable of selecting from the ground exactly the right salts necessary for the growth of the plant. Among other things which the root tip of the wheat plant selects, the most important is silex, or flinty matter, which is made use of in building up the strong, straight stems, so as to render them capable of carrying the heavy ears. It is because this silex is built into the straw of the wheat stem that the chalky districts where there is much flint to be found in the soil produce the best straw, if not actually the very best wheat. At any rate, there is less fear for the farmer that his wheat fields will be beaten down by the wind if he has planted his grain where flint is known to be plentiful. It has been said that there is enough silex in a well-grown wheat straw to make into a glass bead, if it were melted with potash at the end of a blow-pipe.

To return to the three root tips. These gradually work their way into the soil, and as they do so the young wheat plant begins to feel its strength and to grow more rapidly upwards. Now the stem greatly increases in ength, and the colour changes from a pale yellow to a more definite green. The actual shoot seen above ground is not a leaf—it is a cotyledon ; but it is doing the work

REAPING THE GOLDEN CORN

Round and round the gradually decreasing island of standing corn works the harvester, which reaps with sharp, reciprocating blades and automatically binds the wheat into the familiar bundles or "shocks," which are then thrown out on the other side all ready to be stacked and carted to the threshing-yard.

Tattersall

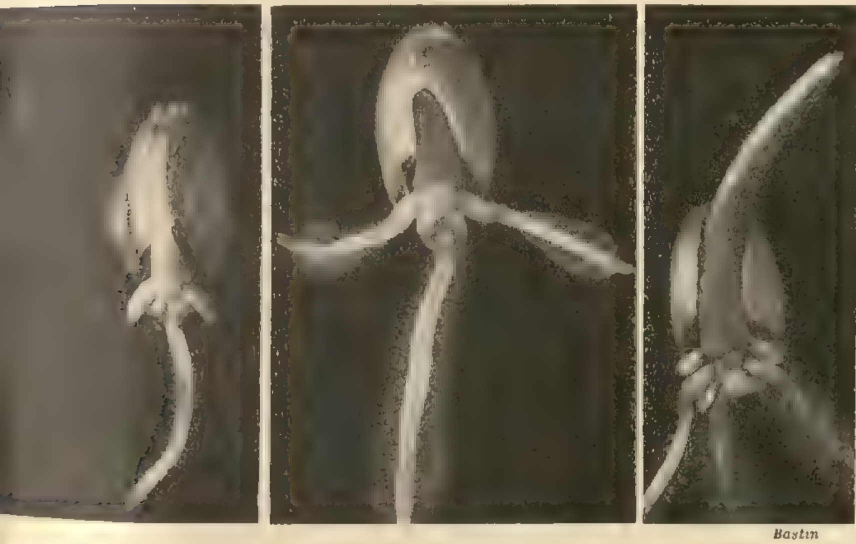


GERMINATING GRAIN

In this series of photographs we see the first stages in the development of a wheat grain. Note the tuft of hairs which collect moisture, and the cleft which acts as an irrigation canal. By the fifth day (extreme right) the primary shoot and root are exposed.

of a leaf until the leaves proper come into being after a few more days of sunlight and warmth, and within its folds the real leaf lies hidden, perfect in every detail and awaiting only the call of spring to set it free.

By noon on the twelfth day the tiny plant starts to send out a second pair of roots, also known as adventitious roots, the sheaths making their appearance and the root tips finding their way into the soil in exactly the same way as the previous ones have done. By noon on the fifteenth day the plant has a system of about five strong roots, all of which are absorbing moisture and the salts from the soil for the benefit of the tissues of the plant, which are by this time badly in need of fresh forms of nourishment.



Bastin

TAKING ROOT IN THE SOIL

On the sixth day (left, above) the first adventitious roots appear, covered with hairs (seen magnified in the centre photograph). By the seventh day (right, above) the plumule begins to shoot. On the right we see the leaf almost freed from the sheath (16th day) and on the 20th day the young wheat plant complete.

Now for the first time the fresh green leaves break through the cotyledonous coverings, and hour by hour they reach upwards towards the sun and the blue of the springtime sky. At noon on the sixteenth day the leaf is practically free, and then, as if the plant realizes that it is still unable to support the weight of the new growths, a sixth root appears and forces its way downwards. After twenty days of growth the young wheat plant is an accomplished fact and stands in the soil complete with six roots and one perfectly expanded leaf.

After this stage the growth of the plant is watched carefully by the farmer, who tends his beautiful field of green leaves by rolling and weeding until the plants become too tall for anything more to be done, and he must leave to Nature the capital he has invested in sowing and ploughing. By August, if the weather is good, a wide expanse of standing wheat will cover the field, and as the wind blows across it there will appear no waves of changing green, but the tall stems will be seen to sway gently and, if the other sounds of the countryside do not distract the attention of the listener, the faint rattle of the ripe grains may be heard.

Because of the little store of food, originally intended for the growth of the young plant, which Nature has laid up in the grain of wheat, this form of vegetable life has become inseparable from the activities of Mankind, and the whole economic system of the Western world in modern times tends to centre round the financial condition of the producers of our daily bread—the farmers.

'IDEAL HOMES' OF THE FEATHERED FOLK

THE achievements of the avian architects are well-calculated to arouse the interest and wonder of every beholder, so neatly contrived are they out of a minimum of materials, and so excellent an example do they provide of the adaptation of means to ends. What follows is in the nature of a detailed study of nests and nesting—a subject which is dealt with in lesser or greater measure in every chapter in this section

No other creatures show such variety in their choice of a home as do the birds. There is scarcely a situation, from the top of the tallest tree to the chimney of the newest house, which may not be selected by some one or other of our British birds as a suitable site for raising a family, and very many young birds are reared every year in situations which to the human eye must seem absurd.

There is no situation too open for some birds, and none too secluded for others, and often the reason for an apparent preference is hard to see. Usually, however, we can with a little thought find out for ourselves some very definite factor in its life that accounts for the actions of every bird, and for the choice, not only of its nesting site, but even of the materials that are employed in building the nest. The shape and method of construction of the nest may also be governed by some circumstance of the bird's life, and even the shape and colour of the eggs are found to be in accordance with more or less fixed rules.

ON THE BARE EARTH

The nightjar provides us with an excellent example of a bird that makes no nest at all, laying its two eggs on the ground and relying on their colour to protect them from marauding foes. In the situation revealed in the photograph below they are still distinguishable, but where the eggs are darker in colour and laid against a background of heather or in the scrub at the base of a bush they are frequently quite invisible.

A. H. Thompson

Equal diversity is shown by birds in their choice of nesting material as in their selection of actual sites for the nest. In general, we may divide nests into those which are exposed, more or less openly, on the branches of trees, or in bushes, herbage, etc.; those which are hidden, often very deeply, in herbage, creepers, etc.; those which are on the ground, either bare and open, or under tufts of grass or vegetation; and those which are in holes, either in trees, or in masonry, or in the ground. None of these categories is completely watertight, for some birds may build a large, open nest in a hole, others a domed nest high up in a tree.

Deviations from the Nesting Normal

At the same time, there are innumerable instances of freaks in nesting habits, of birds that for some obscure reason act in a way contrary to all the accepted rules that apply to their kind. The cormorant, for example, normally builds a large, messy nest of seaweed on a ledge on some high cliff. There are many records, however, of its forsaking a marine haunt and settling on some inland lake, choosing for its nesting site an exposed bough of a tree, and using sticks and water-weeds as the materials. Again, the thrushes and the blackbird nest normally in the trees and bushes of our hedges and gardens, but even such ordinary birds as these may suddenly become eccentric and build a nest in the middle of a bare field, and this in places where there are suitable sites on every hand.

In every one of these classes, moreover, we may find enormous variety. The open nest may be a quite simple grass and stick structure, as with the thrushes, where, however, it has a particularly substantial lining; it may be even more solid, as with the rook; or it may go to the other extreme, and be so flimsy that the eggs show through from below, as is often seen in wood pigeons' nests. The warblers, as a whole, build neat, beautiful nests of grasses; some are flimsy in the extreme, and very open, while others are exquisitely woven together, and slung by long "handles" of grass from the stems of plants or reeds. In the latter case, too, the cup of the nest is usually very deep.

The chiffchaff and the willow warbler, the long-tailed titmouse and the common wren all build domed nests, but they are of a very different character. We may often see the eggs of the chiffchaff and the willow warbler inside the nest without even having to disturb it, but those of the long-tailed tit and the common wren are hidden deep down in a hollow. The wren often further safeguards its nest by placing the entire structure in a hole in a wall or bank.

As much range of variety as any is shown in the nests which are found in holes. The robin is, perhaps, the

S. Crook

SCOOPED IN THE SAND

The ringed plover does not worry over-much about making a nest, as may be gathered from this photograph. A hollow scooped in the sand is sufficient for its needs, though if the nest is on shingle it is ornamented round the edges with pebbles and broken sea-shells. The spotted pattern of the eggs tones admirably with the sand and makes them inconspicuous.

simplest of these hole-builders, for it makes a nest that shows obvious relationships with that of its near cousins that build in the open. A fairly wide hole, usually in a bank, is chosen, and the bird is able to sit and survey the passing scene in snug security, without having to spend the period of incubation in gloomy darkness. The robin, however, is among our most eccentric birds in its choice of site, a fact no doubt partly due to its fondness for the haunts of Man. Wherever Man is, a certain amount of more or less bulky rubbish is bound to collect—old tins, boxes, baskets, flower-pots, and the like—and these form ideal opportunities for the robin's originality. There are several instances of old kettles providing the site for a successful home for robins, and on more than one occasion the bird has even ventured inside a house to find a snug nesting spot on a bookshelf or inside a cupboard.

Another bird that prefers an open and yet sheltered spot, usually a gap or hole in a wall, is the pied wagtail. The nest may be found, however, in a bundle of old sticks or the disused wheel of a watermill, and this bird has provided one of the most remarkable instances of all eccentricities. A pair once built beneath a portion of railway line over which trains were frequently passing.

Many birds build in holes in trees, and these, again, may be divided into two main classes: those that excavate their holes themselves, and those that use old ones. Often, of course, the bird will merely enlarge an old hole, or it may return year after year to one which it made originally. This applies especially to the woodpeckers, which may burrow hard for some inches through the sound wood before reaching the rotten heart of the tree.

EASILY HIDDEN

Like that of the ringed plover seen in the upper photograph in this page, the nest of the short-eared owl does not suggest any considerable degree of care or ingenuity. When the parent bird is absent, the round, white eggs are very obvious, but when she is sitting she is almost indistinguishable from the background, and so her own body is the nest's best protection.

Brook

Once there, they dive downwards, so that a steep shaft is made, at the bottom of which the eggs are laid. After the labour which this entails, it is not surprising that these birds tend to remain faithful to the same home year after year, until the tree rots away or is waterlogged.

Some of our native tits excavate their holes themselves, and it is interesting to speculate why, in a large wood full of old trees, we may find one pair doing their own boring while another pair choose a ready-made site. These birds, again, use the same site year after year, and often show marked eccentricity; a hollow and disused pump is a favourite with them, and an iron gate-post provides similar opportunities that the blue tit, especially, is quick to appreciate. Some birds, on the other hand, even build up their holes, an example of this being the nuthatch, which chooses a hole with a large entrance and then carefully cements it up with mud until it is only just large enough for exit and entrance.

The birds which build in holes are also divisible into those which make no proper nest and those which spend some time on building even inside the hole. The owls, for instance, lay their eggs usually on the bare floor of a hollow tree, perhaps lining it with a layer of dried pellets of their own undigested food; the tits, on the other hand, build a quite substantial lining of moss and feathers, while the jackdaw, when it nests in hollow trees, usually builds the hole right up with a mass of sticks. Anyone who has been unfortunate enough to have a jackdaw building in one of the chimneys of his house will know only too well the large amount of material that bird may use to fill up a hole to reach the required level.

One of the most notable hole-dwellers, the kingfisher, makes a very rough nest of bare fish-bones, and the smell and mess of its nest contrast strangely with the bird's lovely plumage. It is an interesting fact that another of our most beautiful birds, the goldfinch, is also remarkable for the messiness of its nest.

OPEN TO THE WINDS

The moorhen makes no attempt to hide her nest, but relies, it would seem, more on its inaccessibility than on anything else. The great structure of reeds and rushes is lined with rushy fragments, carefully broken up into small lengths, and the fawn-coloured eggs harmonize excellently with such a background.

E. J. Hosking

A. R. Thompson

WARM AND COSY

The linnet, one of our typical passerine birds, builds a small, round, neat nest of twigs and grass with a lining, in the present case, almost entirely of wool. The deep cup of the nest protects it from the eyes of most enemies, and so the need for special coloration of the eggs is obviated.

Some birds do not take the trouble to make a nest at all. Among these we find most of the wading birds, as well as the nightjar and the owls, when they forsake hollow trees for the open air. Others merely use the old nests of other birds, or even usurp their abodes. The starling often ejects such birds as woodpeckers, although it builds a nest in the hole, and many of the hawks are content with the old nest of a pigeon or crow.

One would not think there could be much room for difference among birds sharing such a habitat as the bare ledges of a lofty cliff. The range of nests, however, found amongst our seabirds is extraordinarily wide. The guillemot, for instance, lays its solitary egg on a bare ledge, where the wind may turn it round like a top, while close by the cormorant erects an enormous structure of old and strong-smelling seaweed, and gulls build similar nests almost equally impressive in size and smell. Many seabirds build in holes in the cliffs, or in rabbit-burrows along the tops; others, such as the black-headed gulls, live in colonies, making large nests on the edges of inland waters.

The waterbirds, again, provide us with a mass of interesting facts concerning the choice of nesting sites. The coot and the moorhen and the mallard all make much the same type of nest among the rushes, but the coot and moorhen may prefer to build their own little island,

attached to some half-submerged tree-trunk or interwoven with a mass of waving reeds. The grebes, on the other hand, build floating nests of weeds and rushes, and even the lordly heron may come down from his usual tree-top haunt and make a vast island of similar materials. Ducks very frequently build their nests in elevated positions, e.g., up a pollard willow or other waterside tree. There is even a remarkable but well-authenticated record of a duck building its nest at the top of a church tower. Coots and moorhens share this preference for elevated situations, often building their clumsy nests well above the waterline. For all these birds there is the awkward problem of conveying the young to the water, for they swim long before they can fly. The solution lies, it appears, in the young climbing on to the back of the parent, who gives them a premature aerial trip in flying them down to their proper home.

Sometimes, of course, the nest that is well adapted to one type of situation may be wholly unsuitable for another, but of this the bird cannot be aware. An instance of this is the long-tailed tit's wonderful nest of moss and lichen, which was described in page 121. This nest is admirably suited to the thick hawthorn or

Ian Thomson

PRIZE DESIGN

The long-tailed tit is an expert nest-builder, as the above picture shows. This nest is made chiefly of lichen, and safely ensconced in its deep hollow are the young birds. This is the finest example of nest construction that any of our birds affords us.

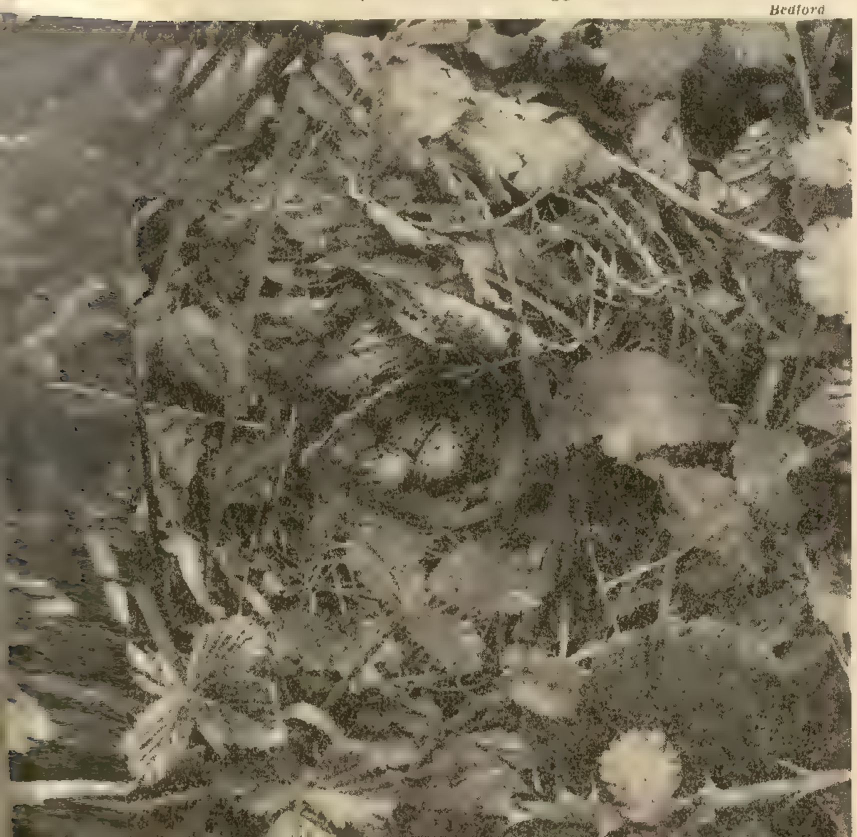
blackthorn hedges in which the bird often builds, for the lichens used grow on the twigs of the thorn, and the play of light and shade in the hedge gives much the same effect as the pepper-and-salt exterior of the nest. But when the bird builds, as it frequently does, in a gorse bush, the lichen loses all value as camouflage, and, in fact, serves only to make the nest more conspicuous.

Mention has been made of the fact that eccentric thrushes and blackbirds sometimes lay their eggs on the ground, and this is a relatively common deviation with many birds that normally build elsewhere. The moorhen, for instance, usually builds a large, irregular nest of reeds in the middle of a reed bed or among the branches of some broken tree where it dips into the water; nests have often been found, however, in the centre of a hay field, far from any water, and in a place where the parent birds, it would seem, have great difficulty in obtaining food for the young.

EXCELLENT OUTLOOK

The nest of the chiffchaff affords an interesting comparison with that of the tit shown above. There is the same domed type of structure, but, as the nest is better concealed, there is no need for so deep a hollow and the eggs are visible from without.

Bedford



Laziness Carried to Its Limit

FINALLY, and most famous of all, we have the nesting habits of the cuckoo, a bird too lazy or too cunning to do anything but convey its egg to the nest of another bird and trust to the parental instincts of a complete stranger.

The photos illustrating this chapter can give, of course, only a rough idea of the complete range that has been referred to above, but they show the major divisions into which nests made by birds in the open fall. In the chapters dealing with the various species of birds themselves, and especially in Chapter 6 (page 165), in which the subject of eggs is more fully discussed, further examples of nests are given, and some idea of the wonderful variety of ways of construction can be gathered. The hidden nests of those birds that build in hollow trees, rabbit-warrens and similar positions are described in the chapters devoted to the individual birds; as nests, they are not prominent enough to attract the attention of the country rambler.

STATELY ELMS IN CLUMP AND AVENUE

NEXT to the oak, the elm, to which the following chapter is devoted, is perhaps the best-known of all our trees. Essentially it is a denizen of the open, rarely encountered in the forest; belonging to the country, but foreign to the wild; not a town tree like the plane, but found in city parks and on urban commons, and never very far from the habitations of humankind

GROWING as they do in the banks and hedges throughout our countryside, elms must be seen by more people every day than any other trees, for it is impossible to look out of a railway carriage window for more than a few minutes without seeing a number of them, standing straight and strong, along the edges of the fields and lanes.

Perhaps for this very reason they are liable to be dismissed from the mind as just trees—trees of no peculiar beauty or particularly striking features, remembered on account of no long-established traditions or customs. For all that, the elm is one of our finest trees, and, although not strictly a native, one of our most characteristic.

Unlike its native cousin the wych elm, the common or small-leaved elm was introduced from the Continent in

Ward

PURPLE FLOWERS

The flowers of the elm, borne in bunches on the bare twigs long before the leaves are out, consist of two styles surrounded by a minute perianth and four or five stamens. Purple in colour, they give to the branches of the tree a distinct ruddy bloom that is one of the indications that spring is come.

Roman times, and rapidly spread and established itself. It is found less widely in Scotland than in England, but is generally distributed everywhere. The main differences between this tree and the wych elm lie in the leaves, which are smaller; the bark of the trunk, which is rougher and more twisted; the shape of the fruits; and the general outline of the tree. The common elm is typically umbrella-shaped, having a straight thick trunk that runs up to fifty feet or more, dividing high up into several branches which grow on upwards and slightly outwards. Subsidiary branches are often given off on the sides of the main trunk, and a feature of these is that they grow straight outwards and then usually downwards, so that their tips may even sweep the ground many feet away from the main trunk. Round the lower part of the main trunk there are often large bunches of short shoots, some of which may grow up later to form quite strong branches. When, as often happens, the top of the tree is split off in a winter gale, these lower branches grow up and form a number of trunks.

The height to which the common elm grows is considerable, trees of 120 feet being not at all uncommon. The girth is not often more than twenty feet, which is rather small considering the height of the main trunk. The bark is always very rough and contorted.

FRUIT AND FOLIAGE

Although they are not ripe until the leaves already clothe the tree, the fruits of the elm, thanks to their curious winged shape and the great bunches in which they are arranged, may easily be discerned through the luxuriant foliage. This form of fruit is known botanically as "samara," from the Latin for elm-fruit.

Ward

Photo, The Times

ELM COLONNADE

If proof be required of the admiration felt by our forefathers for the elm it is surely afforded by the avenues planted in the grounds of so many of our "stately homes." Here, for instance, is the magnificent avenue of elms, two and a quarter miles long, at Wimpole Hall, Royston.

Ovate in outline, the leaves of the common elm have serrated edges, and each one grows unevenly on its stalk, a little ear-like growth often running back along the stalk on one side, and there is an obvious point to the leaf.

In winter the elms appear as stark sentinels in the hedgerows, the absence of many low branches giving them a peculiarly top-heavy appearance. As early spring draws on we may observe a purplish bloom stealing over the larger trees, and examination of the rough twigs will show that this is due to the flowers, which open long before the leaves are out.

The flowers are actually brownish in colour, growing on short stalks direct from the stem in little bunches. The perianth, which is undifferentiated into petals or sepals, is four- or five-lobed with a similar number of stamens. The anthers, which are bright purple, give the flowers their characteristic colour; they surround the two styles. This open type of flower, occurring early in the year before there are many insects about, is admirably adapted to wind-pollination. It is an interesting fact that the fruits are found in large numbers only every two or three years, although there are masses of flowers every year.

The fruit itself, which is ripe about the time the leaves are fully out, is of the type known to botanists as a *samara*, an example of which we have already seen in the ash. In the elm, there is again the flattened "wing," with the aid of which the fruit may be borne by the wind far away from its parent tree, but the shape is very different. The elm samara is bell-shaped, the seed being towards the outer edge, that is, the mouth of the bell. In this edge there is a little notch, and the other edges are slightly wavy. The flowers of the common elm are about $\frac{1}{8}$ inch across, and the samaras are not more than $\frac{3}{4}$ inch long.

Elm wood is used for many purposes for which a strong, hard, durable outdoor timber is needed,

Bastin

LEAFY LIKENESSES

The leaves above seem at first sight to be practically indistinguishable, but they are, in fact, from very different trees. In 1 we see a spray from the wych elm; 2 is a spray from the common elm, also known as the small-leaved elm; while 3 comes from the hornbeam.

but for delicate work or as a builder's timber it is not popular. This is due to the fact that it has a very marked tendency to warp. It has recently been discovered, however, that the wood may be treated in such a way as to make it useful even for fine panelling. Actually, its chief use is for the manufacture of coffins, since there are few woods so durable under damp conditions as elm. Tool handles, wheelbarrows, certain parts of boats and doors that will see much use in the open air are also made from elm wood.

Victims of the Gale's Rage

THE elm has a bad reputation as a danger to passers-by or to human habitations during storms, and this is certainly not without foundation. Not only do even the largest branches break off suddenly, but the tree may be blown in half, and even apparently healthy trees may be blown straight down in a moderate gale. As is always found in Nature, a wounded tree becomes a home for innumerable small creatures of every sort, and the elm is no exception to this rule. It suffers, in fact, from some of the most virulent and important of tree diseases found in this country, of which the principal, Dutch elm disease, has been the subject of research on the part of botanists and entomologists for many years.

The exact nature of this disease is not yet well known, but one of its agents is a little insect known as the elm

LEAFLESS GIANT

In winter one can see the typical umbrella shape that is gradually assumed by well-grown common elms. The presence of small branches low down on the trunk contrasts strongly with the arrangement in such trees as the beech and the oak, and the general form shows this to be one of the stateliest and most upright of all our trees.

E. J. Hosking

BARK CORRUGATION

E. J. Hosking

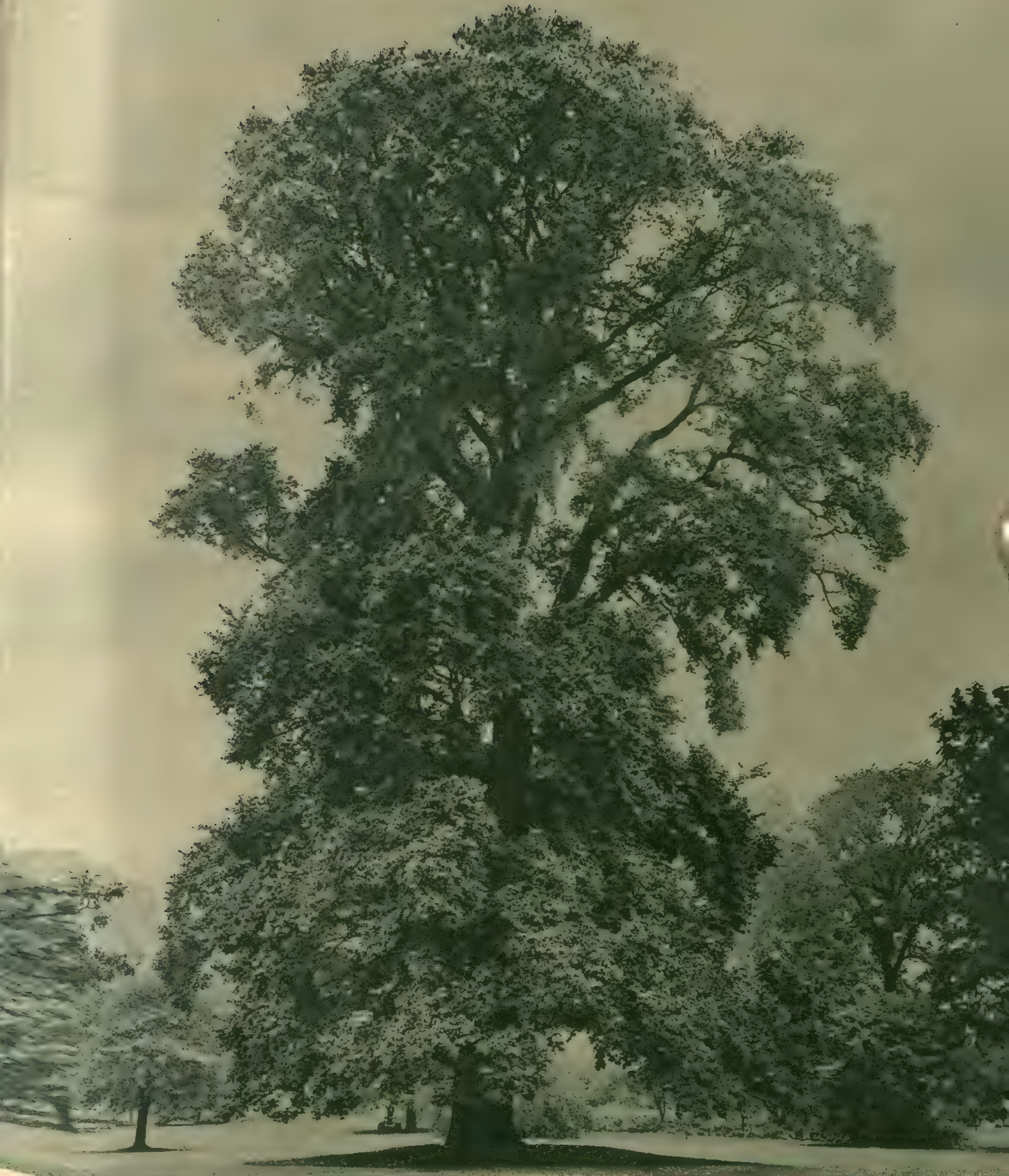
Rugged like that of the oak, the elm's bark may be distinguished by the fact that the individual corrugations are longer and not so deep or broad. The straight, sturdy bole is well supported by the great roots, running buttress-like from the base into the ground.

bark beetle, which is dealt with fully in the section on the Wonders of Insect Life. It is found most easily by stripping the bark off any branch or log that is lying beneath an elm tree, for scarcely a branch falls that is not sooner or later attacked. The outward signs of the insect's presence are a series of little round holes in the bark, a collection of reddish dust on the ground beneath the tree or log, and the stripping or falling off of the bark. Where the insects have been at work we may see the clearly defined pattern of a series of galleries running over the surface of the wood. These galleries are made by the burrowing larvae of the insect, and it is said to be through these galleries that the fungus which is also a cause of the disease enters the tree.

Leaves With Hairy Stings

LIKE most large trees, the elm provides a home for many insects. Amongst these mention must be made of the Large Tortoiseshell butterfly, described in Chapter 4 of Our Butterflies and Moths series, and this brings us to an interesting fact which is not at first obvious. The other members of the Tortoiseshell group all feed on the common stinging nettle, and we find that the lordly elm is quite closely related to that humble plant. Furthermore, the leaves of the elm are covered with hairs which are capable of administering, in a minor degree, a sting similar to that of the nettle. This is especially notable in the leaves growing on the saplings which arise round the base of the elm. It may be that these leaves, growing nearer to the ground within the reach of animals, have more need of protection, and have, therefore, developed the stinging property.

As has been indicated, the elm does not produce a good crop of seed regularly, and its chief method of propagation is by means of suckers from which arise the young saplings referred to above. As a hedgerow tree it is chiefly valuable for the fact that it allows a thick vegetation to grow beneath it, a fact which also makes it one of the most desirable trees in park land.



TOWERING ABOVE ITS FELLOWS

The elm is one of the tallest of British trees, frequently attaining a height of a hundred feet and on occasion exceeding this very considerably. In such an unconfined habitat as that pictured here it assumes the proportions and appearance of a giant, dwarfing the trees in its immediate neighbourhood

EXPOSED TO THE ELEMENTS

The common heron usually builds its nest in the tree-tops, but, as is stated in page 143 in the chapter on nests, it sometimes makes a floating island. In this photograph we see a male bird keeping guard beside a nest of the more common type

Southern

WOODLAND SPRITE

Whether scampering through the undergrowth, scrambling up tree-trunks, leaping with extraordinary agility from bough to bough, or, as in this charming study, sitting momentarily still on a prostrate, ivy-garlanded log, the little red squirrel is a star-performer in the animal troupe

Frances Pitt

Taylor

THROUGH PRECIPICED GORGE

This photograph and the one below illustrate stages in a river's progress —the subject of the chapter which begins in the opposite page. In this picture we see how the Wye has cut through the carboniferous limestone rocks at Monsal Dale, producing a gorge with precipitous cliffs

ACROSS PLEASANT LEAS

This photograph of the Nith near Dumfries illustrates a somewhat later stage in a river's course than is shown above. The country has long since been worn to an almost level state, and the river meanders, here forming shingle-spits and there cutting yet deeper into the hardly-resistant bank

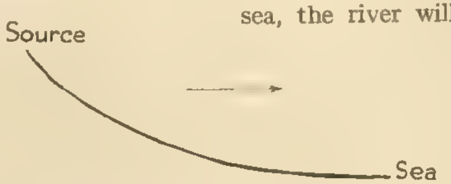
RIVER LEVELLERS OF THE EARTH'S HIGH PLACES

AMONG the forces that have shaped, and continue ever to shape, our landscape, rivers occupy a position of the greatest importance. With unceasing and almost resistless action they pursue their levelling work, wearing down the heights and making the rough places smooth, and it is this modifying work that is described and pictured in this chapter. Further illustrations appear in the opposite page

RIVERS are busy workers; they are always industriously shaping our scenery. But before we examine their sculpturing of our land in detail, it may be well to survey their work in its broad outlines, so as to see more clearly what a river is trying to do.

A river's work can be divided into three categories, *denudation, transportation* and *deposition*. Under the first heading comes the work of breaking up rocks already crumbled by weathering, leaving them open to fresh attacks of rain and frost, and the work done in wearing away a channel by *corrosion* (deepening) and *erosion* (widening). Transportation is the word used to include all that the river does in bringing down material in the shape of boulders, pebbles, sand and mud on its way to the sea. Deposition is the dropping of the material held in suspension, when the current slackens and is unable to carry so much as before.

Now a river is always trying to attain to a state in which it has an even flow from source to sea. When it has reached this condition of gentle slope and steady current, it is said to have achieved its base level of erosion, which may be illustrated diagrammatically (*see* adjoining figure).



BASE LINE OF EROSION

In an ancient river system, the water will flow at an even rate from source to sea, with little variation in either slope or scenery along its length.

Sometimes, in old river systems, the mark is overshot, and the slope of the lower levels is so reduced that the pace of the river is checked, so that the material held in suspension is dropped, forming banks of fine sand or silt, which impede the river's progress.

Let us now follow a river in imagination, from the time the rain falls in the mountains to the moment when a large river pours the volume of its waters into the great sea or mightier ocean.

Dividing the Falling Waters

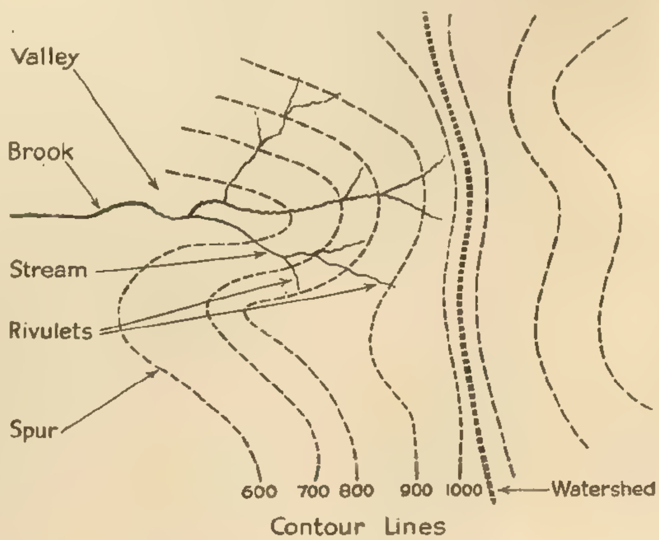
IF the raindrops fall on a mountain, the direction in which they trickle down will depend on the slope of the hillside. Two raindrops may fall close together, yet they may flow in opposite directions and eventually reach different seas. The ridge dividing them is then known as the watershed. If we look at a physical map of England we can see that such a watershed exists along the length of the Pennine Chain, whence rivers flow east and west into the North and Irish Seas.

As the raindrops trickle downwards they run together into little rivulets; the rivulets merge one with another to form streams that tumble down the mountain side to join the brook which runs at the bottom of the valley below. As the brook is fed by more and more streams it swells in volume, until it sooner or later attains to the importance of a river.

At first the brook, formed high up in the mountains, is nothing but a torrent, leaping and jumping over boulders and steep precipices. Its volume and rate of flow are governed by the rainfall, so that in early spring, when it is swollen with the waters from the melting snow, it tumbles and roars its way down, forming a barrier that is difficult and even dangerous for men to pass; while in summer, reduced by drought, it may be crossed by means of stepping stones without fear of wetting the feet. These mountain streams may be seen in many parts of the British Isles, and form a picturesque detail characteristic of the igneous and highly metamorphosed districts of the country.

If, as on the west coast of Scotland, these hard rocks form the land down to the water's edge, whether lake or sea, the river will remain of the same type along its length—fast-running, cutting a deep, narrow channel for itself, and carrying a bulk of coarse material which it deposits in the form of shingle banks where its waters meet the sea and the flow is checked.

But in parts of the country where there are softer rocks, and the rivers have had time to wear them down, there is further and more interesting sculpturing. At first, walking downstream, we may notice a place, at the



TYPICAL RIVER SOURCE

Up in the hills, the very top of a ridge may decide into which sea a river shall flow. This sketch-map illustrates how contours affect a stream in its early stages, the watershed (shown by thick dotted line) dividing the river systems and the spurs, and the spurs cutting off one river valley from the next.

W. F. Taylor

NEAR THE SPRING-HEAD

The source of a river is found high up in the hills where the raindrops collect or a spring gushes forth. For the first part of its journey towards the sea the stream often tumbles over a rocky watercourse, such as is seen in this picture of the North Teign as it flows from off Dartmoor below Yes Tor in the neighbourhood of Chagford.

junction of igneous and sedimentary rock, where there is a great difference in level, since the softer rocks have been worn down more quickly than the hard. Here there will be a waterfall, cascading over the rock and tumbling into a deep pool. This pool will probably be evenly round in shape, and then is known as a pot-hole. If we examine the course of a stream carefully, we shall find more of these pot-holes, and they have a curious origin. At first some irregularity in the river-bed set up a circular current or whirlpool in the river, such as may be seen from time to time. When a pebble is caught in this current it is swirled round and round, carving out a hollow in the river bed. This process is carried on until, quite often, a large pool of circular section is formed.

Formation of Cascades and Pools

More waterfalls and pot-holes may occur farther downstream as hard and soft bands alternate in the sedimentary rocks over which the stream flows; a hard band will resist the wearing of the water longer than the soft rocks, and so will keep the upper portion of the stream at a higher level than the lower.

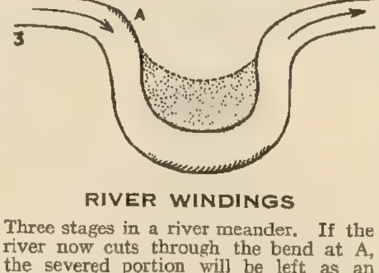
As the river continues on its way it flows into flatter country, where cows crop the long grass. Here the slope is more gentle and the current, no longer rushing downwards, spends its strength in wearing down its banks.

The gentler the slope, the more the river twists and turns. Often we may see a river winding so much that it flows first on one and then on the other side of its valley. If we investigate the curves more closely we shall find that the outside bank of the curve is steep and frequently undercut, where the full force of the current impinges upon it, while by the opposite shore will be a spit of sand or silt, which the slack water has formed by depositing the material held in suspension. Sometimes the river's windings become so tortuous that the stream doubles back on itself. These exaggerated curves so impede the course of the river that it then has to cut its way through the mud or shingle bank that it has deposited, leaving the old channel as a crescent-shaped pool of stagnant water. Pools that are remnants of rivers and which have been left isolated by the streams' meandering are quite common sights in our lowland meadows and plains. Known as "oxbows" they may be recognized quite easily from their definite crescent shape.

As a river gradually lowers its level by wearing down its bed, there may be periods when the rate of erosion is checked, either by a band of hard rock in the bed, or by a diminution in the volume of water passing down the river. These checks, or periods of apparent stability, give the river time to cut terraces for itself, such as may be traced in many old river valleys, e.g., the Thames.

These river terraces are often composed of gravels and contain plant, animal and human fossils of rare interest to the geologist, for instance, in the river terraces of the interglacial periods have been found the tusks and bones of the early mammals that once roamed our islands, and which have been preserved for us only in a few localities where they have been buried by the detritus brought down by ancient rivers.

Along its final reaches the river has lost the power of carrying any but the finest material in suspension. Rocks and boulders impede the course of the mountain torrent, shingle beds lie in the bed of the stream, fine sand will be found farther down, but at the river's mouth, where the waters meet the sea, only the fine silt remains to be deposited. Sandbanks are common in the estuaries off the Scottish coasts, where the rivers retain their force till they meet the sea; but in the south of England, where the rivers have travelled farther and over a gentler



RIVER WINDINGS

Three stages in a river meander. If the river now cuts through the bend at A, the severed portion will be left as an isolated pool. Dotted portions = sand-spits; shaded portions = steep banks.

BABBLING BURN

For some miles after its rise the typical stream [illegible] and marked at intervals by waterfalls and scooped-out poo[illegible] characteristics of immaturity which are clearly seen in this view of a Dumbartonshire burn.

JOURNEY'S END

Where a river meets the sea, its current slackens and much of the material held in suspension is dropped, forming sand-spits and shingle banks such as are seen in this photograph of the mouth of the Welsh river Ogmore. Often the deposition of sediment results in the silting-up of the river mouth.

incline, mud and silt are more common, so much so that the channels have frequently to be dredged in order to allow the passage of vessels up to the harbour.

In this respect it is interesting to note that where a river has to pass through a narrow channel just before it opens into the sea, the constraint will force the current to run faster, thus keeping the harbour clear of sediment. Where rivers broaden out before reaching the sea, the current slackens and the harbour silts up. This is one of the reasons why Liverpool, whose river, the Mersey, has a bottle-necked outlet to the sea, is an important harbour, while Chester, which was once a flourishing seaport, is reduced to the position of a small town, owing to the silting up of the wide-necked outlet of the Dee.

This account of rivers and their work has been confined to mechanical action, analogous to the mechanical action of weathering. There is, too, a chemical action of rivers, as when they dissolve out the calcium in limestone districts, forming underground rivers. This subject is dealt with more fully in the chapter on underground rivers and caves.

We have now seen the course that a typical river pursues. And its object? Always to cut backwards into the hills, wearing them down until it reduces the land to one monotonous level.

NOTES ON RIVER-STUDY

Whenever there is opportunity, examine rivers and their valleys and try to determine what stage they have reached. If the river is slow-moving and placid it has progressed far in its work of levelling the land. If, on the other hand, the waters are rapid and have cut a V-shaped channel, either the river is comparatively young, or else the rock through which it passes is so hard that the stream has been unable to wear down the land to any great extent.

In the upper reaches of a river, notice the great boulders that strew the river's course; their size and weight indicate the torrential force of the flood waters. In the high mountainous country there may be a watershed, the contours of which decide the future course of the fallen rainwater. Examine any waterfalls carefully; these may be due to some natural configuration of the ground apart from the formations, or they may arise from the different degrees of hardness of the strata. If such falls are caused by bands of varying hardness, notice the river channel above and below the falls and see if you can detect any difference, and, if so, whether you can find the cause. Examine carefully any pot-holes you may find. Notice the regular shape of the hollows, and their smoothly polished sides. If possible, procure one or two pebbles from inside the pot-holes; if they have been there long they will have become perfectly rounded with their work of scouring the rock.

In the lower reaches of the river, notice the shape of the banks. If these are steep, the river is still eroding them; if they are smoothly sloping, the river is an old one and is no longer actively wearing them down. Alternate cliffs and sand spits are a sign that the river is starting to meander, though the sinuous curves will probably make this evident; while crescent-shaped pools of stagnant water indicate that the river has meandered in the past.

Estuarine Features

On the sea coast observe the estuaries of rivers. If these are narrow and confined near their exit to the sea, the waters will be constrained and forced to flow swiftly over the last part of their course, and, in consequence, their harbours will be deep and suitable for shipping. If the last part of the river's course is over flat country with sedimentary or alluvial deposits, the river will flow sluggishly, depositing much of its material near its mouth and silting up its harbour.

ROUND THE YEAR WITH THE HUMBLE-BEES

NOT so well known, perhaps, as the honey-bees, but quite as interesting in their social economy and habits, are the humble-bees—bumble-bees, as many people call them—described in the present chapter. The honey-bee is further dealt with in a later chapter in this section of our work

WARM days in January and February may draw forth a few of the rasher members of the great bee community, but it is not until March or April that the hive is fully awake and the cheerful sound of humming insects begins to reach our ears. Round the entrance to the hive the busy workers gather, some active as guards, others setting out on foraging expeditions, their goal the opening spring flowers or the neighbouring stream, as the case may be. If we wait where the flowers are at their best, we shall see not only the honey-bees but others of the bee tribe—some small, some large, all perhaps unfamiliar.

Seeking a Spouse Among the Flowers

THE commonest of these will very possibly be a small bee, whose yellow legs are well set off against the hairy blackness of her body. This is the female of a bee named *Anthophora*, and the males, searching for mates, may be seen flying to and fro near by. They do not settle on the flowers, but merely fly up and down along the row of blossoms waiting until a female shall appear. At first it may not be easy to recognize the males as being of the same species, for they are of a rich yellow brown all over, the forepart of the body being lighter in colour than the rear. *Anthophora* is one of the semi-social bees, living in large colonies in sand-pits and sandy cliffs or banks. Along the hedgerows we may also see a queen humble-bee, large and black, with a red-tipped body, busily seeking a hole in which to start her nest.

A description of the foundation, by the solitary queen, of the wasp's nest has already been given, and the humble-bee community is started in almost the same way; in the case of the hive-bee, however, it is a different matter, for the community is a permanent one, and the queen has no work to do but to lay eggs. Not for her the labour of searching for a nesting site, of building the first cells, and providing for the upbringing of the first members of the family; conducted by a cortège of workers, she travels from cell to cell, laying her eggs and being, in fact, nothing more than an egg-producing machine for the greater part of her life.

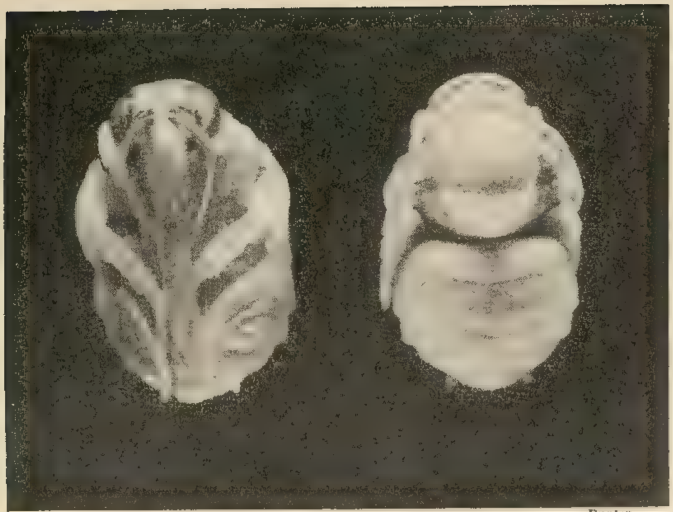
Murder in the Hive

FERTILIZED by a drone or male bee during the previous summer, the queen begins her active life in the hive by an act of wholesale murder, for as soon as she has taken command of the hive she is permitted to kill off any immature or virgin queens that are in the nest. From this time on, until at least the next swarming time, she is solitary, but the term "queen" gives us a grossly exaggerated idea of her functions. She has nothing to do with the community or its government save as the layer of eggs, and it is for this reason alone that she is kept alive. In the spring, after a long period of rest, when the hive reawakes, she begins to lay eggs again, but it is the workers that have the most to do. There may have been considerable mortality during the winter, in which case all the dead bodies must be removed; cracks and holes in the walls must be patched, the air flow of the hive must never be allowed to cease. The maintenance of this is one of the duties of the young bees before they are detailed to what may be called field-work, that is, the collection of pollen and water from flowers and streams or ponds. This is only done by the workers when they have reached a certain age limit, not casually by any bee that chooses to do it. The air flow is kept going within the hive by individuals that may be seen standing in the entrance, their bodies slightly raised, their wings beating regularly for hour after hour. In the hotter days of summer this fanning will be even more necessary, but even in spring it must not stop.

With the humble-bees, as has been indicated, the situation is very different. A single queen, fertilized the previous autumn, wanders to and fro as does the queen

'WHERE THE BEE SUCKS'

The humble-bee is no less assiduous a nectar-seeker than its more domesticated cousin, the hive-bee. Clover is one of the favourite food-plants of all bees, and the insect pictured below was so deeply-occupied that the photographer managed to achieve this exceptionally-fine "close-up."



Bastin

'BUMBLE' ADOLESCENTS

These views of the humble-bee pupa show to perfection the way in which all the features of the adult insect are to be discerned in the adolescent stage. The left-hand specimen shows the antennae and legs, while in the other picture we see the soft pads that are the wings in embryo, folded round over the sides. These bees are about $2\frac{1}{2}$ times life-size.

wasp, until she finds what seems a suitable place to start the nest. In the British Isles there are seventeen species of humble-bees, or bumble-bees as they are also called, the commonest of which, the big, furry " bumbles " that are so noticeable anywhere in the country in summer, build their nests underground.

Social Characteristics of the " Bumbles "

OTHER species of the " bumbles " build just under moss on the surface of the soil, and several choose an empty bird's nest as their home; in the latter case the colony is of necessity smaller, and these bees are also not so pugnacious as their larger cousins. The humble-bee community consists of the same three castes as are found among the honey-bees and the wasps, namely, workers, males and queen.

Having found a suitable hole (for we will presume that we are examining a subterranean species), the queen collects what amounts to a ball of fine grass or soft moss, which is hollow and somewhat resembles a mouse's nest. Inside this she places a mass of pollen which has been laboriously collected and worked up into a stiff paste, and on top of the pollen she makes a single circular wall of wax. The wax is secreted from glands in the hind part of the body, and it exudes through the edges of the segments in small plates.

INSIDE this wall she lays the first eggs, and the cell is then covered with a capping of wax. It is remarkable that the queen then proceeds to brood over the eggs to incubate them, though this is only necessary for about four days, after which the eggs hatch. The little grubs at once bore into the mass of pollen, on which they will feed for some time. At one side of the cell the queen makes a jar-like structure, known as a honey-pot, which she fills with honey secreted from her own honey-glands. This forms the supply of food for herself during the incubation period of her first batch of eggs. In all this she shows a highly-developed instinct that is totally lacking in the queen hive-bee or the wasp.

Bastin

CUCKOO IN THE NEST

Each of our common species of humble-bee has its cuckoos - parasitic insects that kill the queen and then lay their eggs in the nest, the resulting larvae being fed by the unwitting worker bees. The extraordinary likeness of the cuckoo *Psithyrus vestalis* to its host can be seen by comparing this photo with the one below ($\times 2$).

HUMBLE-BEE TYPES

The humble-bees illustrated above are representatives of the three castes of the species *Bombus terrestris.* The queen (top left) is much the largest; then come the drone (top right) and the worker. All three are very hairy; and the queen, who has to do the digging for the original nest, has very stout legs. (About $1\frac{1}{2}$ life-size.)

Several of the solitary bees behave in a somewhat similar manner, but the humble-bee's next step is unique: she gnaws off part of the lid of the cell and proceeds to feed the young larvae on regurgitated food that she herself has partially digested.

After about a week the young larvae spin for themselves a stiff cocoon, and in less than a fortnight the workers are ready to assist their queen in the management of the colony. In the meantime, new cells have been made, each of them containing a dozen or so eggs, and the queen provisions them by foraging expeditions in the same way as the queen wasp. As in the case of the wasps, however, as soon as the young workers are able to take over the duties of cell-building and collection of provisions, the queen devotes herself

solely to the function of egg-laying, while the workers construct new honey-pots. Thus we see that each of the social groups has something in common with one of the other groups.

In the nests of the ground-building species, the number of workers by the end of the season may amount to as many as five hundred.

THE idea that humble-bees cannot sting is a complete fallacy, as anyone who is rash enough to experiment can determine for himself; and when the full five hundred in a nest have been stirred to a frenzy by the inquiring but unsuspecting rambler, his position is not to be envied.

Queen humble-bees for the next season are produced in the same way as the queen wasps, by special feeding up of grubs that have hatched from eggs laid in larger cells than the normal. Males are produced from unfertilized eggs laid late in the season, and in some cases also from eggs laid by workers. The observant rambler may notice a bee in appearance very similar to the humble-bee, but with very dark wings, flying near the entrance to a humble-bee nest. This is one of the cuckoo bees that are parasitic on the humble-bees. Observers who have specialized in these cuckoos tell us that the female cuckoos (there are no workers in the parasitic species) enter the humble-bees' nest and kill the queen; the eggs and larvae of the usurper are then tended by the worker bees with the same care as was previously lavished on those of their own queen.

Bastin

BEES OF SPRING

Anthophora pilipes — "hairy-footed flower-bearer"—is the most typical springtime bee. The male (top) has remarkably long hairs on the middle legs; in the female (bottom) these are absent. (About twice life-size.)

To return to the other little bee which we mentioned earlier in this chapter—the *Anthophora*, one of the most regular of all spring insects—if we were able to follow this bee from the flower patch as she flew to her home, we should find ourselves in some warm, open sand-pit, or against a sandy bank. The sides of the pit are riddled with small holes, into one of which the bee darts; from other holes we see females emerging and flying away in search of pollen. If the colony is a large one we cannot fail to be struck by the atmosphere of bustle which is created by the bees as they fly to and fro, in and out of their cells. There is in this colony no true social life, but merely a large number of little solitary families that live close together, more after the manner of a human society than is the honey-bee hive. Each "house" consists of a tunnel that is stocked with pollen, carefully divided up into cells, in each of which is an egg or a growing larva. These bees, too, have their cuckoos, little black bees with white spots. Their name is *Melecta*, and they may be noticed flying to and fro among the busy colonists as though watching for a female to leave her nest and so give them an opportunity to enter quickly and lay their eggs.

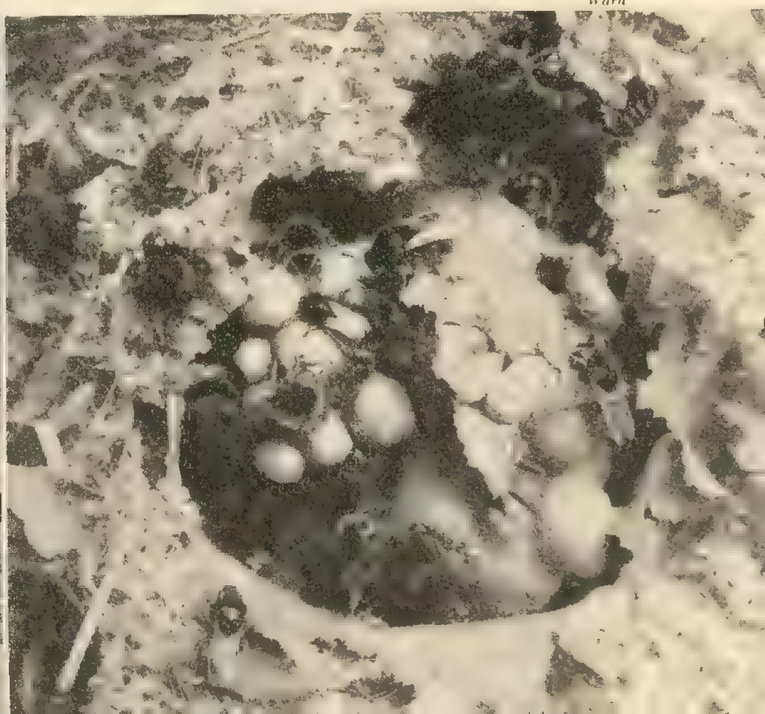
One very interesting point about these *Anthophora* colonies is the length of time they may endure; near Hillmorton, in Northamptonshire, there is a colony that has been in existence for at least two hundred years.

REVEALING GLIMPSES OF A HUMBLE-BEES' HABITAT

Several of our humble-bees make their homes in the deserted holes of other small creatures; the left-hand photograph, for instance, shows the entrance hole of a deserted mouse's burrow, made probably the previous year in the side of a violet-strewn bank, and now in humble-bee occupancy. The other photograph is of the inside of a nest, with several of the bees still at work. The tops have been removed from two of the cells to show the fat, white grubs curled up inside, while in the lower left-hand corner of the nest are some of the old cells which have been turned into honey-pots for the storage of nectar. The materials of which the nest has been constructed are easily visible, the papery lining being of the bees' own manufacture, while the outside consists of moss and chopped grass and straw.

Bastin

Ward



SQUIRREL TUMBLERS IN THE GREENWOOD

PERHAPS it is not too much to say that the red squirrel is the most popular of our wild creatures, for few there are who are not charmed by its nimble ways and handsome presence. The grey squirrel, which is, alas, waging an all-too-successful war against the red species, is the subject of a separate article in this work

THE order Rodentia (Lat. *rodere*, gnaw) is certainly the best represented of all the orders of wild animals found in Britain, there being altogether fifteen different species. The mice, the rats, the voles, the hares and the rabbits are all rodents, while the red squirrel is a good example of a tree-living species. The characteristic feature which brings all these animals together in the same order is the chisel-like formation of the incisor teeth, which are specially devised for gnawing. The rodents have no canine teeth, and another of their distinctive characters is the continuation of the hair of the outer skin into the mouth. Hares and rabbits have the whole of the inside surface of their cheeks covered with hair.

Rodents are very rarely aquatic; the only British example which swims as a natural part of its existence is the water vole. The majority burrow their way into the ground, excavating for themselves long runs and nesting places; while a very few, like the squirrels and dormice, spend the greater part of their lives among the branches of trees.

Of all British rodents the red squirrel, if not the best-known, is certainly the most popular and has for some time figured frequently in the daily press in connexion with its battle with the grey squirrel, a species first introduced into England in 1889 as a gift from an American friend of the Duke of Bedford. Of the conflict between the red squirrel, with Man as an ally, and the grey, more will be given in a later chapter, but it may be stated here that for some years naturalists had well-founded, but, fortunately, unrealized fears that the red squirrel would become extinct in Britain.

J. Kearton

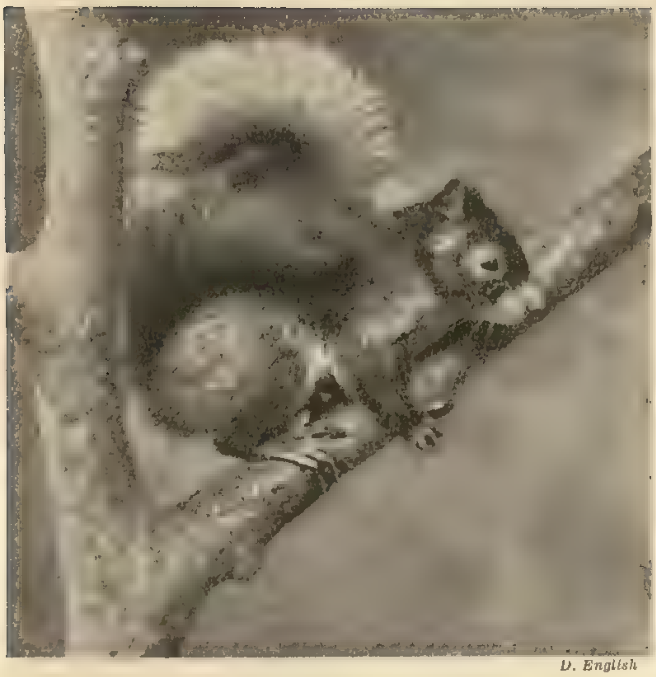
NUTS FOR CHOICE

All squirrels, whichever their species and whether they live in the wild or, like the one above, in a public park, evince a decided preference for nuts. They must be sound nuts, however, and a moment's examination is sufficient to detect a rotten kernel.

EXTRAORDINARILY picturesque when seen sitting on the ground (for they rarely eat in the trees) nibbling away at the shell of a hazel nut or a young larch bud, the squirrel is a particularly suitable subject for a photographic study. It is not so big as it looks, for its long, bushy tail, which is curved over its back as it sits on its haunches, gives it the appearance of being stout, which is quite unjustified. It measures about 15½ inches long from its nose to the tip of its tail, of which 7 inches, or very nearly half, are accounted for by the tail itself. Its feet—one might almost call the front pair "hands"—are especially suited for its climbing activities, and although the palms appear at first sight to be bare, actually they are covered with a thin coating of hair, which gives them special "non-skid" properties. The front pair have four fingers and a rudimentary thumb, while the back pair of feet are provided with five toes, all of which have curved, strong claws. The muzzle has a number of sense hairs growing out from it, while the prominent little black eyes shine brightly through the tufted fur on the face. The ears are not very large, but during the winter thick tufts of hair grow out of them and make them look much bigger than they are. The hind limbs are considerably longer than the front ones, and the heel of the long foot touches the ground as the squirrel runs. The dental formula (as explained in page 77) of the squirrel is

$$i\ \frac{1}{1},\ c\ \frac{0}{0},\ pm\ \frac{0}{0},\ m\ \frac{5}{4} = 22$$

Ramblers often complain that, when walking through the countryside, they see many more grey squirrels than red ones, but this is probably not always true. It is extraordinarily difficult to spot a squirrel at all during the summer, for the leafy branches of the trees hide them from sight. In the winter, however, when the trees are bare, a rambler may see many red squirrels, but most of them will appear far from red in coloration, for they are wearing their winter coats The squirrel changes its coat twice every year, once in the autumn and once in the spring, and although the summer coat has the dull red colour which has given the animal the first part of its name, the winter one is of a greyish-brown, not unlike



D. English

IN SUMMER PELAGE

In the spring the squirrel's tail is a poor sight, but as the summer passes it becomes long and bushy. At the same time the little rodent's fur or pelage is coarsened with increasing length, and the ear-tufts completely disappear.

that of its enemy, the American species. This winter coat of the red squirrel has undoubtedly been the cause of the death of many of these popular little animals, for parties mobilized from the towns with the express purpose of shooting grey squirrels are often not sufficiently versed in natural history to be able to distinguish in winter between the grey squirrel and the red.

Although the fur of the squirrel is moulted twice a year, the bushy tail and the ear tufts change only once in a twelvemonth, the tail appearing in the spring as a meagre, loosely covered brush and gradually growing thicker until winter comes, when it is used for keeping the animal warm. Need for warmth, however, cannot be the only explanation of this enlargement of the tail, and naturalists have been at some pains to find a more satisfactory explanation. According to one theory, the squirrel makes use of its tail as a rudimentary wing when rushing through the air in its long jumps, and this explanation would probably have been accepted had it not been pointed out that there is no difference in the length of the jumps taken by squirrels in summer and in winter, whereas the bushiness of the tail undoubtedly varies during these two seasons.

Signs of Squirrel Sagacity

INTELLIGENCE is one of the squirrel's most obvious characteristics, and it is the possession of this quality that makes it so difficult for us to discover a squirrel in the woodland. On approaching a tree where a squirrel has been seen only a few seconds before, it is sometimes impossible to find the animal again, for it keeps out of view by climbing always on the side farthest away from the observer. If, however, the observant naturalist keeps sufficiently still the squirrel will become impatient of waiting, and, peeping between a fork in the trunk, will spring on its way up the branches and out along a slender twig, until with a final leap it may jump as much as ten yards to the branches of a neighbouring tree. It is curious that the squirrel invariably takes the branch which entails the shortest jump between trees; no naturalist has ever seen a squirrel run to the end of a branch and, finding the jump too long, return to the trunk and start on another one.

Toothsome Morsels from the Trees

THE squirrel eats a large variety of nuts and buds, as well as a few types of roots. It will gnaw at practically anything, and one of its favourite pastimes is chewing old fruit stones. The German naturalist Loens gives an account of some squirrels gnawing at the base of an old oak tree, the bark sap of which had fermented in the sun. The alcohol produced from the sap intoxicated the animals, and his description of their endeavours to carry out their normal gymnastic leaps under these conditions makes very entertaining reading.

The mating time takes place after the long winter months, during which the squirrels, though not actually

A. R. Thompson

PROMISING YOUNGSTER

This young red squirrel gives every indication of sturdy development. It is still wearing its first coat, grown after the initial period of nakedness, but its tail is already of sufficient size to assist in maintaining balance.

FIRST STEPS FROM HOME

Twenty-nine days old, the squirrels seen in this photograph have just emerged for the first time from the nest into the open daylight. Still immature, their resemblance to other young rodents, particularly rats, is sufficiently marked.

hibernating, sleep for many more hours every day than they do in the summer. The male, having selected his mate in February, then fights with the other males, not for the possession of his lady, but for a right to a certain portion of territory in the woodland. An area having been accorded to the couple, they proceed with the building of the nest, or "drey," as it is called, which is composed usually of twigs, moss and strips of bark, and is carefully lined on the inside with dry leaves. Sometimes several nests are made before the female sees fit to take up residence in the one finally selected.

Care and Training of the Young

THE young squirrels are born in March or April, usually two or three at a time, and immediately after their birth they are both blind and without any covering of fur. The mother suckles them during the first few weeks, and then feeds them on titbits from her own diet. After a while she leads them out of the nest, usually built in a secure position between the fork of two large branches, and gives them their first lesson in the art of jumping. They are allowed to go about the trees only on the recognized routes, which the parents devise for themselves when originally building the nest. If disturbed at this season, both the male and the female will greet the intruder first with an annoyed "chuck, chuck," and later with a long-drawn-out, deep-throated screech.

Philologists have been at some pains to discover the derivation of the word "squirrel," and have decided that it comes from the Greek *skiouros*, meaning "shadow tail." Ignoring the aesthetic charm of this name, naturalists, with their greater knowledge of the squirrel's behaviour, are usually in favour of an onomatopoeic origin. The "skee-ow-ow" of the squirrel's screech, with a few changes in spelling, produces a sound extraordinarily similar to that of the animal's name.

Crook

ON THE ROAD TO SAFETY

When a squirrel on the ground is disturbed he at once makes for the nearest tree, climbs a few feet up the bole, and then remains perfectly still until the danger is passed or becomes so pressing as to demand a scampering retreat into the upper branches.

VERNAL BLOSSOMS OF WAYSIDE AND HEDGEROW

CONTINUING our study of Britain's wild flora, we come now to some of the commonest, but not always recognized, flowers that brighten the banks as soon as spring has made its appearance. Celandine, stitchwort, dog's mercury, barren strawberry—how delightful-sounding are the names, how appealing are their modest charms of form and flower!

FROM the accident of their situation, growing as they do in places which almost everyone is apt to miss when hurrying along the road or lane, hedgerow and bankside flowers are amongst the least known of our flora. This is not in any way due to their lack of beauty, for they include some of our most decorative plants, as well as some of the most interesting; but at the same time it cannot be denied that these little plants do tend rather to hide their beauties under lush foliage, leaving it often to the trees that grow above them to attract the attention of the passer-by. Everyone smiles with pleasure at the sight of the first mass of blackthorn in flower, and welcomes the bright show of the berries of autumn; but how many even notice the clear, bright yellow of the celandine or the white stars of the stitchwort which go to lighten and relieve what would otherwise be a wall of dull green vegetation?

One of the foremost plants of the hedges, especially in spring, is the lesser celandine, a plant which convinces us, however little we know of botany, that it is a relative of the buttercups. No other family could produce such shining, brilliant yellows, or petals with so rich a surface that there is ample excuse for the child who would suck them in the hope of finding butter. The starry flowers of the lesser celandine are among the very first to delight our eyes after the passage of flowerless winter, for they are often out in February and seldom appear later than the early days of March in most parts of the country. Even in their name these flowers show their relation with the spring, for the word celandine is derived from the Latin *chelidonium*, the swallow.

The flowers of the lesser celandine (the adjective lesser must not be forgotten, for the greater celandine is no

SPRING'S FLORAL CARPET

This rough corner of a wet and marshy meadow is already ablaze with springtime blossoms, although the trees in the background are scarcely awakened from their leafless sleep. In such situations as this we may find some of the loveliest of our spring flowers, and many more are half-hidden among the lush herbage of the hedge-side in the background.

Taylor

Malby

ON WINTER'S HEELS

One of the earliest of our wild flowers to bloom after the hiatus of winter is the lesser celandine. Hardly has the new year dawned when its shining, heart-shaped leaves make their appearance, and its yellow, cheerful-looking flowers are often out in February.

relative at all) are about an inch across, having eight or nine petals of a uniform golden yellow, and they are well set off by the heart-shaped, shining leaves; there are from three to five sepals. The leaves are almost all radical, and their edges may be slightly wavy; often they are blotched with patches of a lighter green, yellow or even white. The root of the plant consists of a number of small tubers, which are found below the short, thick stem. The plant dies down quite early in the year, and the tubers act as storage organs for the next season. They are also agents in the propagation of the plant, for any small tuber will produce a new plant; for this reason the celandine is as unwelcome a guest in the garden as it is welcome in the hedgerow.

Later than the celandine, and, in fact, taking its place as the chief ornament of many hedges and banks, is the greater stitchwort. This is the plant which, from April onwards, by raising its clouds of white stars far above the other vegetation of the hedge-sides, endeavours to attract our attention. One of the characteristics of the family to which this plant belongs is to be found in the stems, which are round and have very noticeable joints, each of which is slightly swollen. In the stitchwort these joints are extremely useful, for the plant is not very strong, and its ability to turn this way and that by means of the stems helps it to compete with more upright rivals in the struggle for light and air. The jointed nature of the stems is even better seen in the cultivated members of the family, such as the pinks and carnations.

Fertilization of the Stitchwort

THE stitchwort has five green sepals and five white petals, the latter very deeply cleft so that they often appear to be ten in number; there are ten stamens and three styles. Before opening, the buds stick straight up like tiny spear heads, but as soon as the flowers have faded the stalks bend over and the ripening seed vessels hang downwards. The method by which fertilization is ensured in this flower is extremely interesting. Five of the ten stamens elongate shortly after the opening of the flower, curving inwards at the tips in such a way as to leave their pollen on any insect visiting the flower. They do not last very long, however, and as they die down the other five grow up and mature. The three styles then mature, and, if they have not already been fertilized, grow up in such a way as to allow their stigmas to come into contact with the stamens; thus, in the event of cross-fertilization being unsuccessful, self-fertilization takes place. The stitchwort is said to derive its name from the fact that a brew made from the plant was used by the old herbalists to cure a stitch in the side.

STARS OF THE WAYSIDE

Found in almost every rural district, the starry blossoms of the greater stitchwort are as prominent as they are ornamental. Note how the buds stick upright in contrast to the drooping form of the spent flower towards the left bottom corner of the photo.

Taylor

The lesser stitchwort is a smaller, more delicate form of the greater stitchwort. Its flowers might be thought to have ten petals, but there are only five, so deeply cut up as to make them appear to be twice that number. The whole plant is more straggling and delicate than its larger relative, and it is not quite so common, although it is found wherever the conditions are suitable.

Dennis

SHY AND BOLD

In dog's mercury there are considerable differences between the male and female plants. For example, on the female (left) the flowers are borne on short stems among the leaves, but in the male (right) they stick up above the rest of the plant.

A VERY common and very insignificant plant is the dog's mercury. The male flowers are borne towards the top of a stalk some two inches in length; the individual flowers are not quite a quarter of an inch in diameter, and are greenish in colour. Male and female flowers are borne on different plants. In both types the petals are absent, and there are three sepals; the male flower has as many as twenty stamens, and the female has two styles. The female flowers must be sought for, since, instead of growing on a longish stem, they are in little bunches near the bases of the leaves. The whole plant is rather coarse and hairy and the leaves, borne on short stalks, are opposite, and of a longish ovate form, with slightly serrated edges.

The plant is poisonous to cattle, which seem to be curiously aware of its properties, for they will eat the herbage all round and yet leave every plant of mercury intact. Although a very typical hedgerow plant, and one that flowers as early as March, it is seen to greater advantage in woods, where its dark green leaves make a thick carpet beneath the trees later in the year. The plant has a long, creeping root, which makes it an extremely troublesome weed if it ever establishes itself in the garden. The name refers to the fact that the god Mercury was supposed by the ancients to have used this plant for various medicinal purposes.

FLORAL GALAXY

Less conspicuous than the greater stitchwort but rather more delicately-formed, the lesser stitchwort is often found on wayside banks, its straggling stems enabling it to retain a foothold where its not so well-equipped rivals are starved out by the intense competition for the means of survival.

Hinkins

NESTLING deep among the herbage of the shady bank may be found a plant which the rambler feels sure is the wild strawberry; if he makes a note of the locality and returns later in the year, however, he will be disappointed, for there will be no sign of the fruit, all that shows of the plant being a number of enlarged, three-lobed leaves. This is the barren strawberry, whose little white flowers show at least a month earlier than those of the fruitful variety, of which, however, it is none the less a very near relative.

The barren strawberry bears a flower that has five petals, which are set so far apart as to allow the green of the sepals to show in between; these petals are slightly notched at the tip. The sepals are ten in number, and there are numerous stamens, but the whole flower is

Roslin

NOT WHAT IT SEEMS

The plant seen above might easily be mistaken for the one that provides us with luscious fruit for a few weeks in the height of summer. As a matter of fact, however, it is the barren strawberry that is pictured here and not its fruitful cousin.

smaller than that of the true wild strawberry, which is described in a later chapter. The leaves, which grow in a bunch from the root as well as up the stems, are very silky beneath, and the stems themselves are rather hairy. The runners, that are also so characteristic of the true strawberry, are absent, and each plant of the barren strawberry is solitary and independent of its fellows, however close at hand they may grow.

The fruits of the barren strawberry are of the type known botanically as *achenes*, nut-like little bodies each of which consists of a carpel which itself contains a single seed. These are clustered together in a dry little mass, very unlike the succulent fruits that make the true wild strawberry so popular.

There are, of course, many other common plants that grow and bloom beneath the hedges and along the roadsides, delighting the tired wayfarer at all times of the year. Such well known plants as the chickweed, the hedge parsley and garlic hedge mustard are all bound to meet the eye of the naturalist on his spring rambles. Later in the year the waysides become the homes of the creeping and climbing plants, such as goosegrass, traveller's joy and the bryonies; all of these are dealt with in other chapters in this series.

Revealers of Nature. 5

RICHARD JEFFERIES

With the mind of a poet and the eye of a gamekeeper, Richard Jefferies, who was born near Swindon in 1848 and died at Goring, Sussex, on August 14, 1887, holds a distinctive place among British writers on Nature. The former qualification is seen in the intensity and fervour of his style; the latter in his acute and detailed knowledge of the usually unnoticed events of woodlands and downs, events which, having formed the habit of keeping Nature-diaries, he noted down with the greatest care. This combination of the farthest flights of imagination (as evidenced, for instance, in his novel, "After London") with an accuracy of observation that is almost mathematical (revealed, e.g., in "Wild Life in a Southern County," a panorama of Wiltshire, and "Nature near London") is unique in English literature.

Jefferies passed most of his life in poverty. After a shiftless and uneducated youth he became a journalist in London, having already published a few novels which had little success. His name was made by a series of essays in the Pall Mall Gazette, which, appearing as "The Gamekeeper at Home," brought home to Londoners, perhaps for the first time, the poetic beauty and the interesting scientific variety of the countryside. The same characteristics distinguished his "Wood Magic," which came out in 1881. In this he made his characters—the animals—speak and think and experience emotion like human beings, and created the charming character of Bevis, the child to whom their life was fully revealed.

From a bust by M. Thomas

The style of this book, as of some of his others, is a most effective mingling of prose and poetry, for, while written in prose, it rises to heights of intense poetic beauty and reveals imaginative power seldom surpassed in his century. Mid-Victorians and late Victorians, however, gave Jefferies little encouragement, and it was not until the post-war era and the re-awakening to natural beauty due to W. H. Hudson, that he finally came into his own. His subsequent novels and "The Story of My Heart," a mainly autobiographical revelation of ardent emotions aroused by the wonder of Nature, earned him little money, and his last years were clouded by terrible physical suffering as well as by poverty. His other books include "The Life of the Fields," "Red Deer" and "Amaryllis at the Fair."

Jefferies was of an independent, stern and unsociable nature towards his human fellows, save alone towards children; but as he wandered on the downs and through the woods of Wiltshire and Sussex, or in the Surrey lanes near London, observing the animals and birds, his character suffered an entire change.

Inspired by the belief in the possibility of a "soul-life" transcending anything hitherto deemed possible, he experienced a feeling of intimate oneness with Nature, a kind of pantheistic ecstasy that, while it may antagonize some, will as certainly appeal to those who have an ear and eye for the beauties of the countryside. Certainly, whoever reads the books of Richard Jefferies cannot but be the richer in experience and filled with a deeper understanding of Nature, in her minute details as well as in her stormy moods.

MIGRATION OF BRITISH BIRDS

In this plate, showing the general direction taken by bird migrants to the British Isles, we see the so-called summer visitors arriving between March and May from their winter quarters in Africa and other southern lands, and, approaching along a wide sector stretching from north-west to east, the autumn arrivals, known as winter visitors, which make their homes in Britain until April, when they return to their breeding haunts in the lands to the north and east

These waves account for the presence within our shores of the great majority of our bird visitors, but in addition numerous "passage migrants" pass straight across Britain to and from their nesting haunts in Iceland, the northern islands, and Scandinavia.

A number of the birds included among the spring arrivals, e.g. Song Thrush, Lapwing, and Skylark, are not only spring but also autumn arrivals, as well as residents, and many birds that are normal residents may also at times be passage migrants.

SPRING ARRIVALS

1 Ring Ouzel *(Mar.-Oct.)*
2 Wheatear *(Mar.-Oct.)*
3 Chiffchaff *(Mar.-Oct.)*
4 Sand Martin *(Mar.-Oct.)*
5 Willow Warbler *(Mar.-Sep.)*
6 Swallow *(Mar.-Oct.)*
7 Tree Pipit *(Apr.-Sept.)*
8 Blackcap *(Mar.-Sept.)*
9 Wryneck *(Mar.-Sept.)*
10 Yellow Wagtail *(Mar.-Sep.)*
11 Whitethroat *(Apr.-Sept.)*
12 Nightingale *(Apr.-Sept.)*
13 Redstart *(Apr.-Sept.)*
14 House Martin *(Apr.-Oct.)*
15 Cuckoo *(Apr.-Sept.)*
16 Stone Curlew *(Mar.-Oct.)*
17 Common Sandpiper *(Mar.-Sept.)*
18 Lesser Whitethroat *(Apr.-Sept.)*
19 Wood Warbler *(Apr.-Sept.)*
20 Sedge Warbler *(Apr.-Sept.)*
21 Reed Warbler *(Apr.-Sept.)*
22 Grasshopper Warbler *(Apr.-Sept.)*
23 Whinchat *(Apr.-Oct.)*
24 Corncrake *(Apr.-Oct.)*
25 Dotterel *(Apr.-Aug.)*
26 Kentish Plover *(Apr.-Sep.)*
27 Common Tern *(Apr.-Sept.)*
28 Little Tern *(Apr.-Sept.)*
29 Garden Warbler *(Apr.-Sept.)*
30 Spotted Flycatcher *(Apr.-Sept.)*
31 Pied Flycatcher *(Apr.-Sep.)*
32 Swift *(Apr.-Aug.)*
33 Nightjar *(Apr.-Sept.)*
34 Turtle Dove *(Apr.-Oct.)*
35 Red-backed Shrike *(Apr.-Aug.)*
36 Sandwich Tern *(Mar.-Sep.)*
37 Song Thrush *(April)*
38 Lapwing *(April)*
39 Black-headed Gull *(April)*
40 Skylark *(April)*

AUTUMN ARRIVALS

41 Snow Bunting *(Sept.-Apr.)*
42 Redwing *(Sept.-May)*
43 Teal *(Sept.-April)*
44 Mallard *(Sept.-Mar.)*
45 Pink-footed Goose *(Sept.-Apr.)*
46 Little Auk *(Sept.-Mar.)*
47 Hooded Crow *(Sept.-Apr.)*
48 Brambling *(Sept.-Mar.)*
49 Heron *(Sept.-Apr.)*
50 Starling *(Oct.-Mar.)*
51 Waxwing *(Oct.-Mar.)*
52 Fieldfare *(Oct.-May)*
53 Kestrel *(Oct.-Mar.)*
54 Woodcock *(Sept.-Apr.)*
55 Wood Pigeon *(Sept.-Apr.)*
56 Curlew *(Sept.-Apr.)*
57 Pochard *(Sept.-Apr.)*

CRAFT AND CAMOUFLAGE IN BIRDS' EGGS

ALTHOUGH the eggs of British birds are described and in many cases pictured in the chapters devoted to the various species, there are some aspects of general interest that may best be dealt with in a specialized chapter. Below, then, we learn of shape and coloration, number and camouflage, while in the colour plate given opposite fifty eggs representative of the whole range are illustrated in their actual colours and approximate size

A CERTAIN amount of space was devoted in the last chapter (page 140) to the eggs of our British nesting birds, but there is infinite room for discussion on this subject, which is one of the most fascinating of all the branches of ornithology. One of the most obvious points at which to begin the study of the subject is the number of eggs that are laid by each species of bird in an average "clutch," as the whole brood of eggs in a nest is called. The figure varies enormously, even in British birds, but the usual number is four or five, though anything from one to over a dozen may be found. Most species, however, are fairly constant under normal conditions.

A few of our native birds lay only a single egg, and amongst these are several of the cliff birds. These include the razor-bill, the guillemot and the puffin. There is usually a very definite reason for the laying of a single egg, and in the razor-bill and the guillemot this is not far to seek. Both birds lay their eggs on the bare ledge of a precipitous cliff, making no attempt at nest construction, and the conditions are such that it would be impossible for the bird to incubate more than a single egg. The guillemot's egg is pear-shaped, and there was at one time a theory that because it was this shape the egg was enabled to spin round in the wind without falling off, simply revolving in a circle around its smaller end. In actual fact, the birds live in such vast communities that they are forced to incubate the eggs in an almost standing position, the egg being held lengthways beneath the body. A further point of interest about the guillemot is that no two eggs are ever alike. The ground colour may vary from white, through yellow, to green, red, blue, purple or brown, while the markings are of any colour and shade. These markings consist at times purely of curious scribbled lines, at others of spots, large or small, and at others, again, of blotches and whole patches of dark colour. There may even be bands round the egg that are quite devoid of any markings, and pure white eggs are not uncommon.

WITH regard to their eggs the owls are of considerable interest, for they lay usually from four to eight, but singly, at intervals of several days, instead of laying them all and then starting to incubate. The result is that in an owl's nest we may often find all stages, from half-grown young to new-laid eggs, with the bird dividing its time between feeding the former and incubating the latter.

IN SOLITARY STATE

An example of a bird which lays only one egg at a time is the gannet. Set in an untidy nest of grass and seaweed, the single egg is coloured a bluish-green, but owing to the bird's extraordinary habit of covering the egg with its dirt-encrusted feet, it often presents a decidedly miry and stained appearance.

H. N. Southern

R. Gaze

SAFE IN THE OPEN
This common tern's nest is a mere hollow in the bare sand, but the eggs are admirably adapted to their situation by their colour and small markings. Notice the tracks of the bird's feet leading to and from the nest in all directions.

A few of our birds lay two eggs, this group including such widely separated species as the golden eagle, the wood pigeon, the divers, and the nightjar. All of these make a fair attempt at a nest excepting the nightjar, whose eggs are deposited on the bare ground. The birds that lay from three to six eggs are extremely numerous, this group covering examples of every type of bird and eggs of nearly every shape and colour. The wading birds and plovers are especially regular; they almost invariably produce a clutch of four eggs at a time. The reason for this is very interesting. They are ground-nesting birds, and their eggs are all rather pear-shaped. Four such eggs laid together, the points inwards, exactly fit the little hollow, scooped out of the sand or grass, which serves these birds for a nest, and any smaller number would tend to lessen the value of their protective resemblance to the situation in which they are laid.

The ringed plover has been the subject of much interesting research, since its eggs are laid usually on the bare shingle of such sites as the Chesil Beach or the sand dunes of Norfolk. The eggs vary in strict accordance with the type of background. On a sandy shore they have only a few small spots, but where they are laid among larger pebbles and stones with a greater variety of light and shade and colour, the markings will be larger. Sometimes, too, the bird decides to make a little ring of sea-shells, fish bones and other débris round the eggs; this is ornamental, perhaps, but scarcely merits the name of nest!

As was remarked in the last chapter, many birds lay their eggs in holes, and eggs so placed are nearly always white, although sometimes they may be blue. Now it is of interest to note that the rock dove, from which the domestic doves are descended, lays its eggs usually on a ledge, in a cave or cleft in the sea-cliffs which it inhabits; the stock dove, too, always lays in a hole in a tree, a ruined building, or even in a rabbit burrow; the common ring dove or wood pigeon, however, and the turtle dove both build nests of flimsy sticks, with no covering for the eggs at all. And yet all these four species lay exactly similar eggs, pure white, about one-fifth to one third longer than they are broad; there is only a slight difference in size. These white eggs are typical of the birds that build in holes, so that it would seem that the ring dove and the turtle dove have altered their habits from those of their ancestors without, however, any alteration in the shape and colour of their eggs.

It is curious that some of our smallest birds are amongst the most prolific; the long-tailed tit, for instance, may

PEBBLE PROTECTION
The eggs of the little tern, two in number, are laid on the bare, pebbly beach, but their shape and colouring is such that they might easily be mistaken for pebbles. The sole effort in the way of nest construction appears to be the collection of broken bits of oyster-shells scattered around the eggs.

J. I. Hosking

E. J. Hosking

INGENUITY IN THE FACE OF DANGER

The nests seen in these photographs (left, a snipe's; right, a redshank's), each containing its full complement of eggs, show to perfection the way in which the colour and shape of eggs help in disguising them from the bird's enemies. The snipe's eggs are laid in a rough hollow among the coarse grasses of the meadows, and their large spots and blotches of dark colour approximate to the similar forms among the grasses. The clutch of redshank's eggs occupies a situation that demands a finer form of decoration, and hence the eggs bear a far more delicate pattern than those of the snipe—one which enables them to tone well with the finer grasses among which the nest is placed.

lay as many as a dozen eggs, and the other tits and the chiffchaff up to eight. No other birds in their own class lay so many eggs, and this state of things may to some extent be correlated with the fact that all these birds build either in holes or else construct domed nests where the eggs cannot easily be seen from outside. To find other birds that make such large clutches we have to go as far as the game birds, the pheasant and the partridges, which often have up to twenty eggs in a nest. These birds, moreover, sometimes share a nest, so that even larger clutches may be discovered. The wild duck, the moorhen and the corncrake also lay up to ten eggs.

One very extraordinary fact has been noted in relation to the moorhen and the coot, and that is, that instances are recorded of each of these birds laying single eggs in the nests of the other bird. This may perhaps be accounted for by the fact that the nests and eggs are rather similar in appearance, but even so there is a considerable difference in size ; perhaps it is sheer laziness on the part of the hen bird, who lays her egg in the first convenient spot !

Strange Patterns in Egg Markings

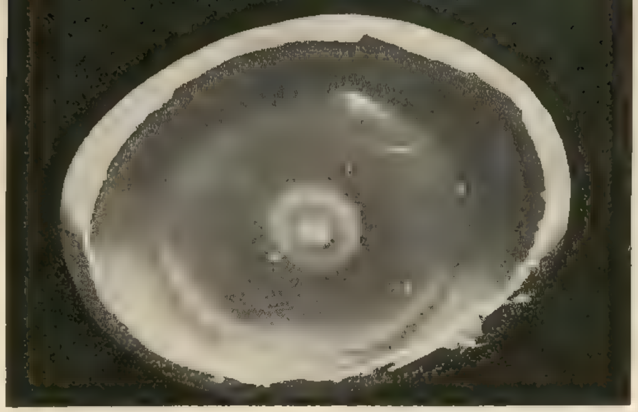
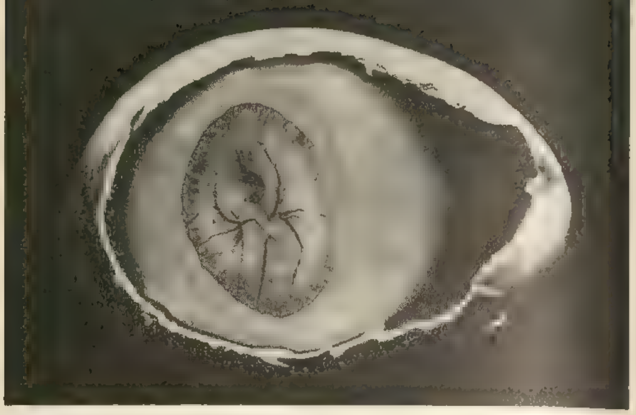
Enormous variety is also shown in the markings that appear on the surface of eggs. The buntings, for instance, forsake the usual arrangement of spots and dots for a mass of curious lines that look rather like shorthand notes, so that the country name, "scribbling larks," is easily understood. The eggs of their near relations, the finches, also at times show signs of this type of marking. This may be of value as camouflage, since the nests are usually built in rough bushes or among grasses on the ground; but there are many other birds, nesting in similar situations, which survive without these marks.

In some birds, however, the protective value of the coloration of the eggs is unquestioned. This applies

ROUND DOZEN

Some birds lay one egg only, some two ; some—the partridge, for example, a clutch of whose eggs is seen in this photograph—as many as a dozen or even a score. Partridge eggs are devoid of any marking, but their brownish colour matches well with the leaves and grasses amid which the nest is generally placed.

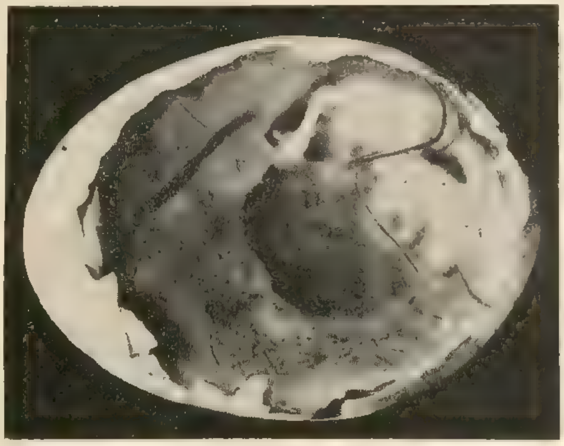
A. B. Thompson

FIRST SIGNS OF DEVELOPING LIFE IN THE EGG

The rather more than life-size pictures in this page show the incubatory process inside the egg of a domestic fowl. On the left is the position about twelve hours after incubation has commenced. The white patch in the middle is the centre of activity, where the cells develop to form the embryo. The speed at which development takes place may be appreciated by comparison with the right-hand photograph, taken when the egg was only three days old. The principal blood vessels are well-advanced, and the mass of yolk, from which the growing embryo draws its nourishment, is decreasing in size. In the middle of the embryo can be seen the mass of cells that will develop into the head of the chick.

especially to the wading birds and the plovers already mentioned, for their eggs are laid on the bare grass or shingle, and anything unusual in the way of a colour scheme would be fatal to the eggs. So successful is the colour scheme of the green plover's eggs, a yellowish- or greenish-brown background with darker spots and blotches, that we may cover a field in which we know there is a nest hundreds of times without ever being successful in our search for eggs. The same is true of the eggs of terns and ringed plover when they are laid on the shingle.



The pictures on this page illustrate the development of the domestic chick during the period of its being in the egg. The shell is carefully cut open with sharp scissors, care being taken not to disturb the yolk, and the embryo is displayed within. This is a simple experiment that can be carried out with any fertile hen's-egg.

LATER STAGES IN THE GROWTH OF A CHICKEN EMBRYO

Continuing the story of embryonic development, we see in the third photograph (above), taken when the egg was eleven days old, that some parts of the future chick are now well-formed. One tiny leg, in particular, can be clearly seen, and in the next picture (left, below) the effect of another four days' development becomes evident. The head is more or less distinct, and the whole embryo is seen tightly curled up inside the egg. In the last picture (right, below) the chick is almost ready to emerge, and the feathers—wet, of course, and covered with slime—can now be recognized. The process is practically the same for all the birds, although there are variations in the incubation-period.


NOTES ON EGG-COLLECTING

That the practice of egg-collecting should not be carried too far and should be completely avoided in the case of all rare birds, has already been emphasized, but the following remarks on the best ways of setting about making a collection may be of use to those who wish to secure specimens of the eggs of our commoner birds.

The easiest and simplest way to blow an egg is to make a hole in each end with a pin and then blow out the contents with one's mouth. This method may be tried till one is sure of holding the egg so judiciously as to escape breakage. A drill and blowpipe should then be purchased from a dealer in Natural History requisites. Eggs may then be properly blown by making a neat round hole in the centre of one side, and expelling the contents through this alone, using the blowpipe.

Clearing the Egg

In both methods a pin should be inserted to break up the yolk before the blowing process is begun. If an egg is hard-set, that is, if the bird inside is partly formed, the embryo bird should be cut in pieces with fine scissors, and the bits withdrawn with a pair of fine-pointed forceps, but the taking of such eggs should be avoided. An alternative way of getting a hard-set egg cleared is to make the hole, or holes, in the egg, and then place it on an ants' nest; the ants will do the rest. When cleared, the eggs should be thoroughly washed out with water injected by means of a fountain-pen filler or similar instrument. Care should be taken to avoid wetting the egg more than can be helped, for the colours of some eggs run, especially when they are new-laid.

After washing out, the hole or holes in the egg should be closed by gumming a tiny disk of paper over the opening. Each egg should be marked with a number with a fine pen and marking ink, catalogued, and put away in an egg-cabinet.

THE WILY WAYS OF REYNARD THE FOX

MANY of the wilder animals of Britain have been exterminated by human agency, but the fox, economically useless though it be and despite its inroads on the farmers' poultry, shows no sign of disappearance. Paradoxically enough, as is explained below, it owes its preservation to being hunted

NONE of the wild animals which still survive in present-day Britain, not even the noble red deer or the playful otter, has given rise to a more extensive and noteworthy literature in both poetry and prose than the fox.

Most of the stories written about and around Reynard have the chase as a background, and the remainder, including, for instance, Aesop's Fables, are concerned with the animal's cunning; consequently many people, perhaps most, are inclined to think of the fox as either an animal to be hunted in time-honoured style, or as a semi-traditional symbol of low sagacity. To the naturalist, however, the fox appears in a very different light, for to him the merit of the fox is no greater and no less than that of other similar mammals such as the badger and the otter—animals which remain relatively unhonoured and unsung, but whose habits are of equal entertainment.

Known to scientists by the name of *Vulpes canis*, the fox, one of Britain's carnivores, is a predatory mammal allied to the dog and the wolf, and resembling them in appearance, though differing from them considerably in habit. For the fox is a solitary animal, living alone except at the mating season, and hunting its prey by careful stalking, never by pursuing its game in packs as does the wolf. Most people are familiar with the main features of the fox, having read or heard of them even if they have never been so fortunate as to see one in its natural surroundings; they know of its long, low form covered with reddish-brown fur, paling to a yellowish-white on the belly, the black tips to its prick ears and on the forepart of its "pads" or feet, its long bushy tail tipped with white, and the narrow, almond-shaped eyes with their elliptical pupils; they know, too, of its peculiar strong smell.

Betrayed by Its Smell

IF when walking quietly through the woods the rambler notices this peculiarly pungent smell, he should stop and take a careful look-round. A fox has most certainly passed that way, and if he is lucky he may catch sight of it poised with one foot raised and head cocked inquiringly as it views the intruder, though most likely all that can be caught is a glimpse of a red streak as it vanished into the undergrowth.

The fox is not an easy animal to watch; both the facts that he is a predatory animal and that he is the object of the chase have combined to make him particularly wily and astute. Cunning and skill are as necessary to evade the huntsmen and hounds streaming across the field in full cry as they are to capture prey.

Some people think that there are two distinct species of foxes in the British Isles, and that the large hill-foxes of Scotland, or Tods as they are called, are quite different from the smaller, redder foxes of the south. This is not so; there is only one species of fox found in present-day Britain, and such things as colour and size are a matter of local variation and not racial difference. Yet sometimes on Dartmoor one may see a fox so much larger and so much darker than the average that a person without much experience but with preconceived and fixed ideas of the vulpine characteristics may well be excused if he falls into what is a very common error, and makes a radical distinction where none exists.

THE diet of the fox is varied—in fact, he is a carnivorous animal verging on the omnivorous, for though rabbits, hares and unsuspecting birds form his principal

LITTLE RED ROVER

Taken in the mountains of Central Wales, this photograph shows a young fox just about to leave his earth in a conveniently-placed rabbit burrow. With ears pricked and up-lifted nose he senses if the moment is opportune for his emergence.

A. Brook

Vickers

RABBITS FOR DINNER

Included in the fox's dietary are poultry, rabbits and hares, rats, moles and beetles. Sometimes he manages to secure a lamb or fawn; sometimes hunger compels him for the nonce to be a vegetarian. Here we see cubs devouring rabbits brought to the lair by their parents.

food supply, he will adapt himself to whatever food comes to hand, eating grubs and beetles, and on sea-coasts even feeding off crabs. But good red meat is the fox's chief article of diet; and this is why, when wild game runs short, he makes such depredations among the stock of farmer and poultry-keeper. So great is his love of chicken that the fox will show considerable ingenuity in entering chicken-runs and slaughtering the wretched birds. There are stories of the large, wild hill-foxes of the north country carrying off lambs in spite of the vigilance of the shepherd, and a tale is told of a fox and vixen attacking a full-grown sheep. In one fox-earth in Scotland twenty pairs of grouse, a couple of lambs, and several rabbits and hares were discovered. When there is any choice, the fox is very particular as to his food, always choosing the best available. Thus he steals the fattest of the old hens perching in the farmyard and orchard, though this may be because they are too clumsy to get far up the trees, or the upper perches in the poultry house, and roost on the ground.

IN THE MOUTH OF THE DEN

When they are six weeks old, fox cubs make their first acquaintance with the light of day, though not for some time yet are they allowed by the anxious parents to roam beyond the burrow entrance. There they spend hour after hour in pretty gambolling.

Brook

A. R. Thompson

ALMOST SPENT

" Snapped " in the undergrowth of a coppice, this male or dog fox is panting hard as if he has just managed to shake off his pursuers after a long and exciting chase. Note the broad head, flattened brow and tapering muzzle.

One feature of the fox which has made its life more difficult is the presence of secretory glands situated beneath the tail which emit the scent by means of which foxes have been followed for so many generations. It is because of this pungent smell, the huge size of the lair or earth, and the animal's regular habits that it has been necessary for the fox to evolve its notorious cunning in order to enable it both to survive and to chase and seize rabbits, hares, and other swift-footed creatures that enter into its menu. The fox's methods of hunting are indeed, well developed, for not only does it spend most of its time seeking food for the cubs, but it also keeps itself in practice and has been known to kill much more prey than it can eat. In exactly the same manner as a setter follows the scent of a bird, Reynard creeps towards his unsuspecting prey and, when sufficiently near, tightening his muscles, gives a sudden spring. Once his jaws have seized his victim, he loses no time in dispatching it and often makes use of his claws in doing so.

There is a common belief among country folk that the fox's cunning is developed to a much higher degree

SAVED FOR THE HUNT

The fox cubs seen in this photograph were dug out of an earth only half a mile from the parish church of Melton, in one of the most famous of the hunting districts. Their parents have been killed, and in due season their brushes, too, may be hunted.

Barrett

than more critical naturalists will admit. That the fox is clever is undoubtedly true, and sometimes, when hunting rabbits or poultry, the animal adopts an open and extraordinarily interesting method of attack. Rolling over and over on the ground in full sight of his prey, he mesmerizes it by his curious antics and then, slowly working towards his victim, he gives his sudden leap, and catches it after his usual manner. If his prey is not required for immediate consumption, he buries it in a quickly prepared grave, covering it with soil ploughed up by his nose.

The teeth of the fox are very sharp; the creature's dental formula, expressed in the same way as in the cases of the other animals described in previous chapters (*see*, for instance, page 77) is:

$$i\,\frac{3}{3},\quad c\,\frac{1}{1},\quad pm\,\frac{4}{4},\quad m\,\frac{2}{3} = 42$$

The two large canine teeth are those of which most use is made in the capture of other animals. The incisors are small, sharp, and very effective in battle.

During the month of January the male fox seeks for a mate and, calling to her with a dog-like bark, finds a home for the expected family. During this period one may hear the scream of the vixen, and it is a noise that one is unlikely to forget, sounding as though a horse were trapped in agony or a man being murdered. It has happened that people, unaware of this characteristic of the vixen, have actually organized search parties to bring aid to the victim of some tragedy which they imagined must have occurred.

Three months after mating, the young, blind cubs arrive; but by this time the vixen is comfortably settled in an earth. Unlike the badger, the fox does not make his own earth, but utilizes the holes of other animals, keeping the former tenants away by the pungent smell which thus, for once, is a useful agent.

The young "whelps," born in April, numbering from three to six, are blind for the first ten days of their life. But after about a month the vixen takes them out for exercise around the mouth of the earth. It is at this stage that they are taught to hunt, and the lessons in the art of catching their prey are continued throughout the summer, until with the coming of winter the young ones leave the parents and go off into the world to seek their fortunes for themselves. They will, however, not be fully grown until another year has passed, and it is during this interval that they are hunted as a means of breaking in young fox-hounds.

Care-free Gambols of the Cubs

The young foxes or cubs are very attractive little animals, and, like all the young of the wild, play together in a kittenish manner. If one is lucky enough to watch a fox "earth" at evening when the cubs are romping together, rolling over and over and pulling and snapping at each other, one can take pleasure in the spectacle as revealing Nature in one of her more delightful moods; later, perhaps, the vixen will come trotting back with a young rabbit dangling from her fangs, and one will be reminded of the fact that bloodshed and killing are ugly but essential occurrences in the everyday life of the animal world.

Such has been the popularity of the fox in literature that his main characteristics are now almost proverbial, and his cunning, his speed in evading capture, and his keen senses are known almost universally. Yet had it not been for Man's invasion of his life the fox would now have been practically extinct in this country. We owe to fox-hunting alone the fact that there are still foxes roaming the English countryside, since without protection by the "hunts" Reynard would have been wiped out long ago by the irate farmers, though the hill foxes might still have survived among the mountainous regions. Until about two centuries ago foxes were regarded as vermin, and were systematically hunted with a view to their extermination, but in the eighteenth century fox-hunting became the fashionable sport that it has ever since remained. In the "grass country," particularly in what are called the "shires" in the centre of England, no pains and expense are spared to ensure that the

ON THE SCENT

As might be expected from the conditions of his life, the fox has a particularly keen sense of smell, and his inherited powers of scent are developed under the vixen's tuition and by constant practice. Is it an unwary fowl whose recent passing the cub seen in this photograph detects?

A. R. Thompson

Barrett

TALLY-HO!

It is to the hunting fraternity that the continued existence of the fox in this country is due. Fox-hunting is a fashionable sport, and from November to April there are "meets" in all parts of the country. Once on the run Reynard can keep galloping for hours with hardly a pause to take breath.

race of foxes is not allowed to die out, the solicitude of the local M.F.H. often extends to the provision of artificial earths built so as to ensure that the vixens shall have comfortable breeding quarters. Strange though it may sound, then, it is yet true to say that the fox has survived because it has been, and continues to be, a favourite object of the chase.

When hunted a fox soon appreciates the fact that the hounds are on its track, and adopts many a wily subterfuge to throw them off the scent. Thus cases are on record of hard-pressed foxes jumping into the middle of a flock of sheep, running about manure heaps, taking to water and then doubling on their tracks, and running among others of their kind and stirring them into activity. Sometimes we are told of an old, badly-winded fox taking the place of a younger who leaves the security of the earth to draw away the hounds from its elder. Many a time the hounds are baffled and the fox slips away into some convenient hole in the ground, a drain-pipe, perhaps, or conduit, or may manage to reach a stretch of woodland or some rocky place where it is too dangerous for the hunt to follow. Thus he escapes—perhaps to be hunted another day.

In conclusion, then, in the fox as in all animals, one can find much to like and much to dislike, playful cubs and cruel fangs, the characteristics of the hunter and of the hunted; but to the true naturalist all such distinctions of behaviour, habit and appearance are merged in the one absorbing task of studying the animal as an animal.

HOW TO WATCH FOXES

The mammals of Britain undoubtedly constitute a very select group of animals, but none moves so much among the aristocracy as Reynard the Fox. In a work such as this, dealing with natural history, the reader cannot expect to find reference to the methods by which foxes may be hunted, either with horse and hounds or with a gun. In more savage parts of the world the gun constitutes a necessary part of the naturalist's equipment, but here in civilized Britain the camera is to be more highly recommended by the scientist and lover of Nature.

"Fox-watching," if so the sport can be designated, must necessarily be carried out at night, although Reynard may sometimes be seen skulking along a ditch or behind a hedge during the very brightest summer days. It is not difficult to find where the fox has established his home, for this is made only too evident by the obnoxious odour which comes from the lair. It is usually in an old badger sett or an enlarged rabbit hole—often one that has been enlarged by poachers when ferreting for rabbits. If a hide is built some little way from the fox's earth, observations can easily be carried out and the gambols of the young cubs, the reproving snaps of the vixen and the homecoming of the foraging father of the family may be watched from day to day.

For those who live in the town it is as well to suggest the various areas where foxes are likely to be found. Since the great hunts deliberately preserve the foxes, it is safe to assume that Reynard will be found at home in most of the districts which are hunted regularly during the season. It will often happen that a naturalist finds numerous earths stopped up artificially, either with bags of cement or by means of stakes and barbed wire. This has been done on the orders of the Master of Foxhounds of the local Hunt, who has gone to great pains to discover all the earths in the district in order that they may be stopped to prevent Reynard from "going to earth" during a chase. During the breeding season, on the other hand, when hunting is temporarily in abeyance, the Master of Foxhounds makes special earths in order that vixens may give birth to their cubs in safety.

MEADOW FAVOURITES OF THE LATER SPRING

COWSLIP and oxlip and purple orchis—these are the flowers described and pictured in this sixth chapter of our survey of Britain's wild flora. Each is a favourite with both those whose homes are in the country and town-dwelling visitors to the rural scene, and the latter in particular will appreciate the distinction that is drawn between the cowslip and the closely-related and very similar oxlip

WHEREVER there are smooth, clayey meadows, usually on a limestone soil or on the chalk downs, we may find in spring a carpet of golden cowslips, dotted here and there with the straight, strong, flower-spikes of the purple orchis. This is one of the most beautiful and colourful of all the decorative schemes with which Nature delights us in our wild flowers, for in both form and colour the two set off each other admirably. Small wonder is it, then, that these are amongst the most popular flowers with the country children, who pick them in great bunches, without, however, seeming to decrease the stock to any marked extent.

The cowslip is a very near relative of the primrose, and it shows many of the features that have already been

BELLS OF THE COWSLIP

Prized alike for its beauty and its scent, the cowslip is one of the most characteristic members of the wild flora of April and May. Its bell-like flowers constitute an easily-recognizable feature, and others are its tall stem and crinkled leaves.

Dennis

discussed in the chapter dealing with that plant (*see* page 12). There is the same dimorphism adapted to ensure cross-fertilization, and the flowers are, in the same way, known as "thrum-eyed" and "pin-eyed." The arrangement of the parts of the flower is exactly the same, and the colour is much the same yellow, although it is rather richer in the case of the cowslip. But here the resemblance ends. While the primrose is a plant of the woods and sheltered hedgebanks, the cowslip is happiest on the downland meadows and in the hollows of the hills, wherever there is enough soil to give the roots a firm hold.

IN the cowslip the flowers are funnel-shaped, the five petals uniting to form a long tube, with a small yellow cup at the top; the sepals are almost as long as this tube. The flowers are borne in bunches of from five to twenty in a simple umbel at the top of a stem which is normally six inches in height. This stem is round and velvety, and, where the plants are growing amidst thick vegetation, it may be a foot high. The leaves are all radical, and of the type known as spatulate, a portion of the leaf running down to the very base of the midrib.

Mention has been made in page 11, in the chapter dealing with the primrose, of a variety of the plant in which the hidden stem is prolonged upwards. This variety is often described as an oxlip; wrongly, however, for the true oxlip is a very uncommon plant found only in the eastern counties, Bedford, Cambridge, etc., whereas the primrose variety is of wide distribution. The difference between the true oxlip and the primrose variety is in the size of the flowers, which are not so wide or so open in the oxlip as in the latter, although in both cases they are borne on an umbel, as in the cowslip.

Hybrids of Primrose and Cowslip

BESIDES the variety of the primrose mentioned above, the true cowslip and the true oxlip, there are a number of hybrids between these various forms. One is the cross between the cowslip and the primrose, illustrated in page 175, which can be distinguished from either of these two plants by taking careful note of its various features. The stems are thick and woolly, and the leaves are of cowslip type, while the flowers are borne in umbels: in these features it differs from the primrose. The flowers have a wide open mouth, and are turned upwards to the sky. In the latter feature they are markedly different from those of both cowslip and oxlip. Finally, when we compare this hybrid with the true oxlip we find that the flowers have the dark markings towards the entrance to the corolla tube.

In a cross between a primrose and a true oxlip, we find that there are no markings in the mouth of the corolla

Dennis

OXLIPS ARE RARE

The true oxlip, shown in the photograph above, is easily distinguishable from the cowslip by the wider flowers, with no dark marks in their centres, the shorter stems, and the less deeply cleft calyx. The oxlip is a rare and local plant.

tube, and the flowers are still borne in an umbel on a longish stalk. They are, however, rather more wide open than in the true oxlip, in this point resembling the primrose, and they are directed upwards. The calyx is short with deep teeth. The entire area in which the true oxlip grows has been carefully mapped, and anyone finding what appears to be an oxlip outside that area should be very careful to make sure that he is not mistaken in his identification.

Most Common of the Wild Orchids

The second of the flowers that is so characteristic of the hillsides in spring is the early purple orchis. This is our commonest and most widely distributed orchid, and one that is easy to recognize. Care must be taken, however, to distinguish it from several other species that are superficially rather similar; these include the green-winged meadow orchis and the marsh orchids, which are described in Chapter 9 of this section. The purple orchis is equally at home in the shady oak wood or the grassy hillside, and is, in fact, one of the most popular of all our wild flowers, for the fine spikes of purple flowers and the handsome green leaves with their liver-coloured spots are visible throughout the whole season.

Comprising some forty species in the British Isles, the orchids have blossoms that at first sight seem to have none of the features of the ordinary flower. The following description of the purple orchis flower will serve to show the way in which petals and sepals are arranged so as to give the many curious forms into which these flowers are at times modified.

The petals and sepals are often indistinguishable as such, and are, therefore, collectively described as a perianth; this is in six parts, all of which are usually large and more or less brightly coloured. The three parts which are really sepals are generally alike in shape and colour; in the purple orchis they are pointed and purple in colour. Two of them stand rather upright above the flower, while the third sticks forward in between.

In the orchids the whole flower is twisted round, in a way similar to that found in the violets, so that the part that appears as the lowest petal is actually the uppermost in the bud. This lowest petal, moreover, is much larger than the other two, being usually flattened to form what is known as the lip. In the purple orchis this lip is purple with a number of darker spots, and, as in most orchids, it is produced backwards to form a long, hollow spur, which, in the present case, however, contains no nectar-glands. The other two petaloid parts of the perianth are similar in shape to the sepals, and in the purple orchis form a sort of hood over the top of the

NOT QUITE AN OXLIP

The dark markings in the centre of the flowers of the plant seen below show that it is no oxlip; its manner of growth distinguishes it from the primrose, and the way in which the flowers stand up show that it is not a cowslip. As a matter of fact, it is a cross between the primrose and the cowslip, and might easily be mistaken for an oxlip by the passer-by.

Dennis

M. H. Crawford

OUR BEST-KNOWN ORCHID

The early purple, most widely distributed of our native orchids, is easily recognizable by its upright spikes of curiously-shaped purple flowers. The leaves, shining green with purplish spots, appear early in spring and last till late autumn; besides forming a rosette on the ground, they clothe the stiff stems.

flower. They are also spotted with darker purple than the general ground colour.

At the base of the little stalk, or *pedicel*, on which the flower is supported there is a small bract which, together with the pedicel and the whole stalk on which the flowers are borne, is coloured purple. The internal structure of the orchid flower is irregular. There is only a single stamen, which is united with the style to form what is known as the column, and this bears the single anther and the two stigmas. A third stigma is present, but this is modified to form a beaked process that appears as a little hood over the entrance to the tube of the spur. In the early purple orchid the top part of the column is the anther; the front of the column, towards the lip, is hollowed out to form a sticky cup-like depression. This is made from the two remaining stigmas, which are fused together and quite unrecognizable as stigmas. The ovary is of the type known as inferior, that is, it is below the perianth, and it is this, in fact, that is often twisted to give the flower its reversed position. When the flower is in bloom this ovary appears to be the pedicel, and it is only later that it enlarges and becomes recognizable as a seed-case.

When a Bee Visits the Orchid

In the orchid the pollen is carried in two bodies known as *pollinia*, each of which consists of a mass of pollen, carried at the top of the anther, and a little stalk that runs down to terminate in a sticky disk just above the entrance to the tube that leads to the spur of the lip. When a bee visits the flower, it attempts to reach the nectar in this spur, and in so doing displaces the pollinia, whose disks stick to the front of the bee's head. If the pollinia remained in exactly the same position, they would obviously come into contact with similar organs on the next flower visited by the bee. They, therefore, move forward, by a bending of the stalk, in such a way that, when the bee reaches another flower, they are in just the right position to meet the sticky masses of the stigmas. Cross-fertilization is thus ensured.

There are innumerable adaptations of this type in the orchids, almost every species having a different arrangement, but the general plan is that outlined above.

Propagation by means of the tubers which act as storage organs for the roots also occurs in the orchids. If an orchid plant is dug up it will be found that there is one active tuber for the present year, and one that is growing up to take its place in the following year. The new tuber may divide, and in that case two plants will appear the next year, although they will very probably not flower that year. This accounts for the fact that on revisiting a locality where we have found a certain orchid, we may see only a green shoot, or perhaps no shoot at all, for several years, and then suddenly a number of flowering shoots will be visible.

HOW TO PRESS FLOWERS. 3

The last note (page 93) concluded with the flowers being placed in the press.

If the drying-papers are not frequently changed the flowers will lose their colour and turn brown. Yellow-flowered and dry, wiry plants can be left unchanged for 24 hours, but others will need changing in 4-12 hours. The moister the plant the more often it will want new drying-papers. Place the press on the table, with the flower end to the right. Unstrap it and place the top board on the table with four sheets of newspaper upon it. The top piece of drying paper has now to be peeled off the plant it covers. Lift the right edge, and pull it back very carefully, smoothing down the plant and loosening it, if it sticks, with a paint brush. Then take off any scraps of blotting-paper and smooth crumpled leaves and petals with the brush.

If necessary, a few snippets of dry blotting-paper should again be put over the flowers, and around prominent parts, then a clean drying-sheet is placed over all. The plant has now to be turned over carefully, so that the damp sheet is uppermost. This is then peeled off as was the other, and replaced by a dry one. The whole is then moved on to the empty board and covered with newspaper. When all the papers have been changed, fasten down the straps once more, and put the press away with heavier weights upon it. The wet sheets can be dried and stored for use again.

Storing the Plants

As soon as the plant is thoroughly dry it should be taken from the press and stored away between newspapers, ready for mounting. Some plants may be ready after about the fourth change, but if not absolutely dry the flowers will mildew. Mount a plant within four days of its being removed from the press, if it is stored away loose. If, however, a spare press is kept, and the flower is put straight into this between sheets of white paper, it can be kept unmounted for some considerable time.

On the whole, however, it is always best to get all one's specimens mounted as soon as possible. This not only ensures against any chance of their becoming damaged, but also makes for neatness and method. There can be nothing more annoying than to come across a number of specimens, it may be of some particularly prized flower, that have been left neglected and forgotten for months, while the press in which they lie has shifted and they have, perhaps, been ruined.

Care should be taken to keep the presses and the mounted specimens in as air-tight a place as possible, and they should be examined from time to time to see that no mites or minute insects have attacked them.

THE PRACTICAL BASIS OF WEATHER FORECASTING

MOST students of weather phenomena, whether they be amateurs or professed meteorologists, are inspired by the desire to be able to predict the weather, if not of next week, at least of tomorrow and perhaps the day after. In the second chapter in this section of our work we obtain some insight into the way weather forecasts are prepared

WEATHER forecasting is today an exact science dependent upon the study and understanding of a vast mass of meteorological data and a proper appreciation of a number of complex physical laws. Gone is the authority of the rustic weather prophet, whose prognostications were in general merely matters of guess-work and in fulfilment frequently inaccurate.

As issued for public guidance, weather forecasts in Britain usually cover a period of not more than 24 hours. Such forecasts are published in a definite form, and include: a statement of the wind speed direction at the earth's surface, together with an outline of the changes likely to occur; a similar statement as to wind at a height of 2,000 feet, and a probable appearance of the sky with regard to clouds, together with statements as to the possibility of rain and concerning the temperature likely to be experienced, especially if it is likely to be higher or lower than the normal for the time of year. Notes are also added as to the probability of thunderstorms, frosts or any other special features. Visibility is dealt with in full, and indications given of the distribution of any fogs or mists likely to be present.

It is now recognized that there are definite meteorological systems, such as depressions (or "lows") and anti-cyclones (or "highs"), which retain their identity for periods of days and frequently travel long distances, carrying their characteristic distribution of wind and weather with them. Wind and pressure distribution "make" the weather, and charts of monthly isobars, showing how the pressure over Europe diminishes gradually from south to north throughout the year, with permanent low pressure near Iceland, demonstrate the effect of pressure gradient upon wind velocity.

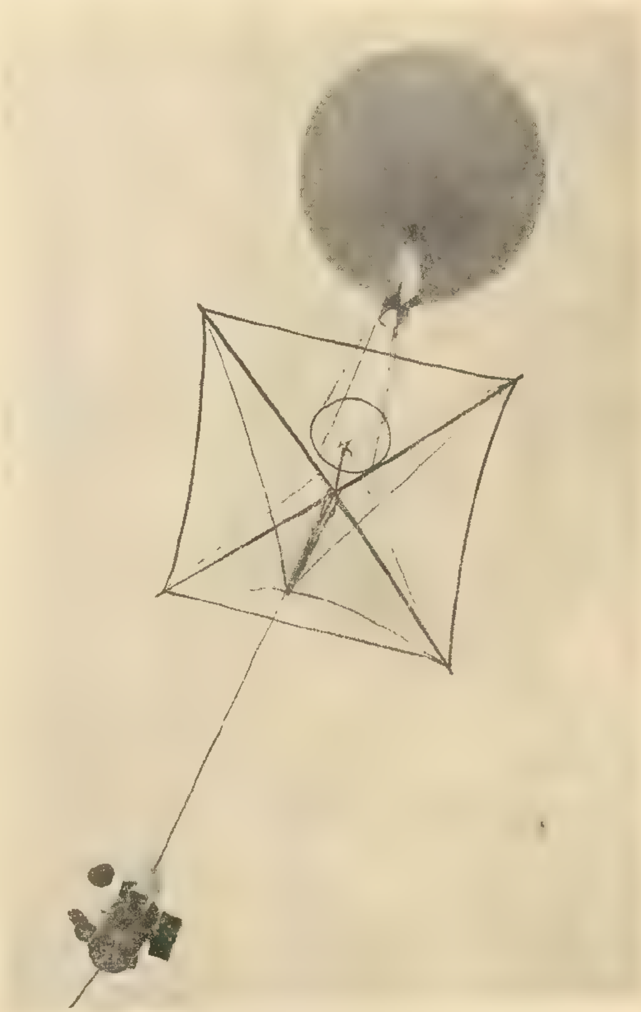
FACTORS responsible for the exchange of cold polar air masses with the warm tropical air masses are the depressions and anti-cyclones, which may be described as huge turbulent eddies developed in westerly and easterly air streams. Two currents of air, markedly different in temperature and speed, may flow adjacently, and, as one succeeds the other, may produce distinctive conditions of weather phenomena at a given locality. The boundary lines between such currents may extend hundreds of miles.

Normally, air currents can be followed from day to day, and when they meet suddenly warm air is pushed up over cold air, so creating characteristic weather conditions. From this it will be seen that it is not the anti-cyclones and depressions that are the determining factors of weather change, but the interactions between the various air masses governed by the wind systems.

Boundaries between two air masses are referred to as frontal surfaces, and the intersections of these surfaces with the ground are called fronts. Accordingly, depressions form initially as small waves on a frontal surface, and later develop into roughly symmetrical vortices.

Forecasts are no longer based upon observations made at ground level, but depend upon data collected at a height of many miles above ground and sea level. The radiosonde, or miniature weather station, permits weather "soundings" of the atmosphere to be made up to a height of 12 miles.

Radiosonde consists of a balloon-lifted radio transmitter which, as it rises 1,000 feet a minute into the upper air, signals to a ground station reports on tempera-

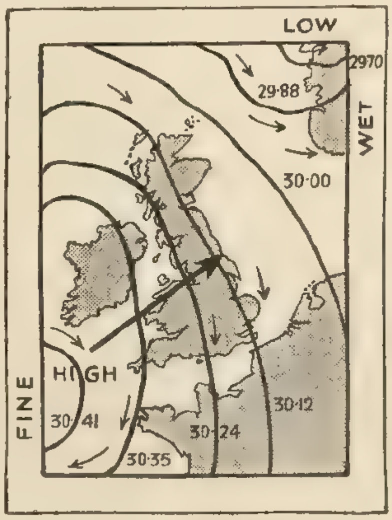


RADIOSONDE

Radiosonde equipment ascending into the upper atmosphere. Readings from the instruments at the end of the cable are signalled by a small radio-transmitter to a ground receiving station. The frame aerial is immediately beneath the parachute below the balloon. Each month 1,000 radiosondes are released and about 50 per cent. are recovered.

ture, pressure and humidity. A large, gas-filled balloon lifts, in order of suspension, a parachute, a metal frame radar target, 120 feet of aerial, and, attached to the end in a metal container 12 in. long, the transmitter and recording instruments. The transmitter emits radio signals which change note as the weather-recording instruments are affected by the changing meteorological conditions through which the balloon passes. At the same time, radar plots the balloon's course, so providing data for wind direction and speed. When it reaches 60,000 feet, the peak of its ascent, the balloon bursts, the parachute opens, and the remainder of the apparatus is lowered to earth.

In the British Isles are nine radiosonde stations situated about 200 miles apart, and ascents are made four times daily. Ground observers note the transmitted data on graphs, and the results are teleprinted to the meteorological headquarters at Dunstable.



Other aids to weather forecasting include the observing from a wide network of sites the atmospherics due to lightning flashes; from cross-bearings distant thunderstorms can then be detected and their movements plotted. As thunderstorms are frequently associated with the cold front of depressions, observation of lightning flashes provides valuable information relative to ordinary weather changes.

By means of radar, cloud types can be identified and warning received of the approach of rainstorms. The nature of the radar echo from a collection of water drops largely depends upon the size of the drops, consequently it is possible for a radar beam to establish the concentration and distribution of the drops in a cloud. Similarly, the refraction of radio waves by the atmosphere affords a means of studying the humidity gradient upon which depends the refractive index of the air.

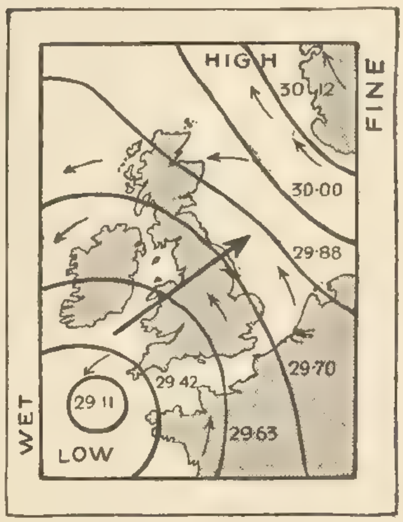
Many influences governing the weather over the British Isles originate far out in the western and northern seas and for many miles above their surface. Consequently the practice of modern forecasting is assisted by the careful collection and collation of hundreds of data reports issued at regular intervals by observers on ships at sea.

Selected merchantmen in the North and South Atlantic, maintaining regular radio watch, transmit at fixed times their local weather conditions and trends. This service is supplemented by the ten weather ships sited at specific points in the North Atlantic and administered by the International Civil Aviation Organization. The meteorological staffs of these vessels take observations by means of radiosonde, and these data, together with sea and surface temperature readings, are transmitted to shore stations.

Data from land, sea and radiosonde observations are received at the central forecasting bureau. There the meteorologists have charts showing the usual distribution of air currents, and determine from the reports coming in what types of weather system are likely to mature. Comparison of the current chart with previous ones allows an estimate to be made of the probable direction and behaviour of the various systems present; from this it is possible to visualize what the charts of six, twelve or twenty-four hours hence will look like.

Fortunately, the courses which the wind may take, the variations of temperature, and the general conditions of the weather over a single area of the British Isles do not vary so greatly as might be supposed. Weather charts for the South of England indicate that for any particular time of the year the general meteorological factors show little variation during the course of a decade.

Two maps typical of those issued by the Meteorological Office are reproduced on this page. The upper map shows the approach of an anti-cyclone, or high-pressure system, from the south-west. The lines or isobars indicate that a centre of relatively high pressure is situated in the Atlantic, south of Iceland, and the large arrow, giving the direction of the movement of the system as a whole, shows that the centre is approaching the British coast from the S.W. The figures indicate the degrees of pressure and the arrows the wind direction.



According to this map, fine weather may be expected. The skies will be clear, the winds light and blowing from the north-west in the north, from the north in the midlands, and from the north-east in the south. As the high-pressure system is rather a large one, it will take a long time to pass over; consequently the fine weather may last for a week.

On the lower map a cyclone or low-pressure system is approaching the British Isles from the same direction as the anti-cyclone illustrated in the upper map. On the lower map, however, pressures are less and the winds are blowing from different directions. On this occasion, therefore, the meteorological conditions forecast overclouded skies and drizzle on the east coast, where the pressure is still fairly high. But near the centre of the system conditions will become worse, with rain and generally stormy conditions at Land's End. Over most of the country, rain and bad weather will prevail until the system passes on its way.

Where the lines or isobars on a weather map are very curved, the system is a small one and will pass quickly. But when lines are close together and less curved, strong winds and generally stormy conditions may be expected.

MASTERPIECES OF THE SPIDER'S CRAFT

AMONG the wonders of animal craftsmanship, the " slimy gins " of the " subtle spider," to use the phrasing of the 17th century Samuel Butler, have always occupied a high place in popular estimation. In this chapter the technique of the web-making craft is explained and the sequence of operations fully illustrated

THE power of the spider to spin beautiful threads of silk and to weave them into complex, exquisite webs has been observed by Man from the remotest times and has formed the subject of numerous superstitions and legends. Greek mythology contains the story of Arachne, from whose name the class of animals to which spiders belong has been taken. Living in Lydia, this maiden acquired great skill in weaving. Her patterns, in fact, were so beautiful and her work so faultless that she took it upon herself to challenge the goddess Athena. The goddess, displeased at this presumption of a mere mortal, accepted the challenge and took as the subject for her work her quarrel with Poseidon, intending it as a warning to such as would dare to pit themselves against the immortals. Arachne, in turn, chose as her subject the metamorphoses of the gods, and by weaving pictures of them into her work illustrated their adventures in full. When the contest was over Athena, discovering that there was no blemish to be found in the work of Arachne, took up the beautiful cloth and tore it into shreds. This action of the goddess threw the Lydian maiden into such despair that she hanged herself, but the gods, taking compassion on her, loosened the rope about her neck by forming it into a cobweb, and Arachne turned into a spider and was forced to spin for all time. An interesting story which gives some idea of how the spider's art attracted the attention of the ancients.

From a scientific point of view the main features of the spider have been dealt with in the previous chapter (page 55), and for this reason the present chapter is devoted not to any particular species of spider, but to a study of the spinning activities of these wonderful animals.

Silken Cocoons for Spider Eggs

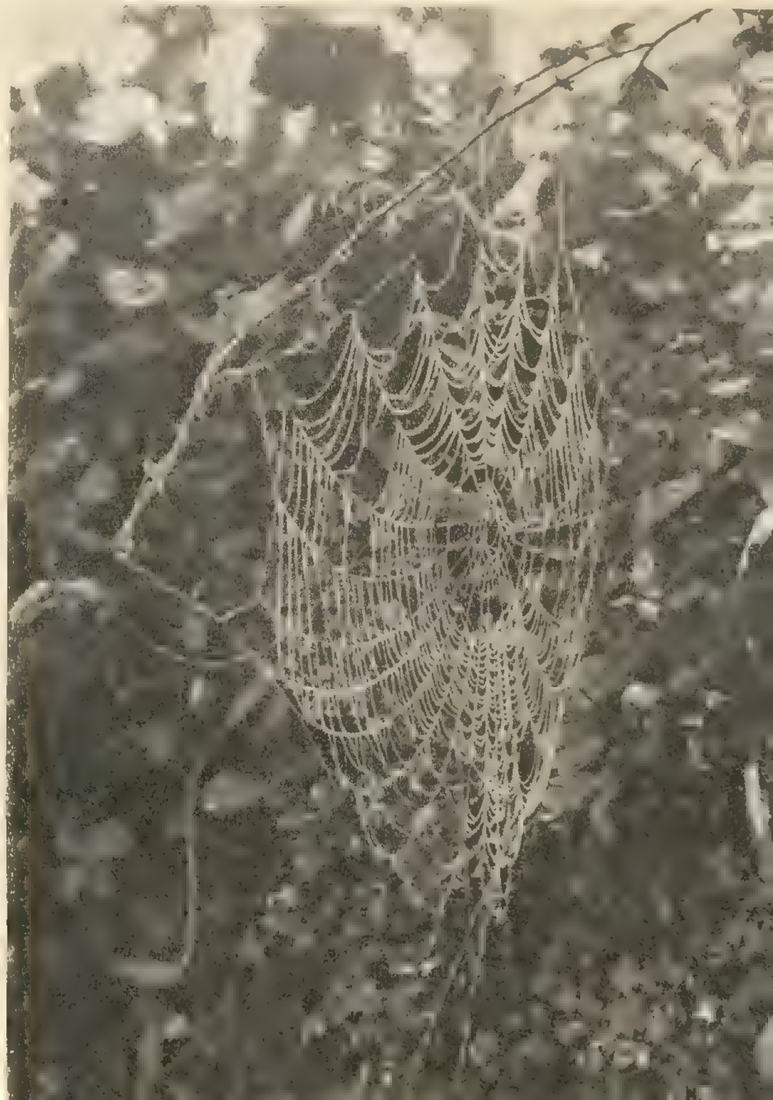
EVERY spider is capable of producing silk from its spinnerets, but the uses to which this silk is put are very varied. There is only one manner in which *every* spider makes use of its silk, and that is in the production of a cocoon for the eggs. This, it would seem, is the primary function for which Nature originally provided the complicated spinnerets and the silk-producing glands contained in them. Every spider encloses its eggs, but this proceeding may be carried out in several ways. Some spiders plant the eggs on the underside of a leaf and spin their threads loosely around them, forming a flocculent, seamless mass, which holds them in position. Other species spin this cocoon covering in two parts, the eggs being first laid on a sheet of threads put down beforehand and then enclosed by another sheet which is spun over them, while the edges of the two sheets are joined together at the end. Sometimes pieces of gnawed bark and small pellets of mud are incorporated into the structure of the cocoon, giving it a much more solid formation, and often camouflaging its appearance.

But although cocoons are made by all species of spiders, the habit of web making is to be found in comparatively few only, in spite of the fact that spider silk is more popularly associated with webs. The numerous different forms of webs found all over the world are constructed with the same end in view, and that is to make use of them as traps for the spider's prey. The common house spider, which is perhaps the best-known species in this country, weaves a simple " cobweb " in any place which may remain for more than a few days undisturbed by the brush or duster of the housewife. The evolution

BEDEWED GOSSAMER

The beautifully-woven web of the spider looks its best during the very early hours of the morning, when the fine threads are covered with microscopic drops of dew. When the building of the web is in progress the spider never forgets to allow for the possible extra weight of deposited moisture.

F. Martin Duncan



J. T. Roberts: J. J. Ward

PAYING OUT THE LINE

The upper photograph shows a garden spider (× about 3) paying out a silken thread from its spinnerets, while in the lower we see a section of the thread magnified 75 times. On the latter the sticky globules which hold fast the spider's victims are visible.

of these flat, loosely-spun sheets of silk is particularly interesting, for it shows the first step in the process of the construction of the more complicated trapdoors and tunnel webs.

In the marvellous accuracy with which the construction of these traps is carried out we have an excellent example of the mechanical ingenuity achieved by animals which have no apparent method of thinking. Darwin tried to explain the behaviour of the spider in building its web in the same terms in which he explained, at any rate to his own satisfaction, the way in which the wasp and the bee build the octagonal cells of wax in their cones. The outside thread of a spider's web is not necessarily symmetrical in the figure which it traces, and it is only later, after the radii, or spokes, have been added, and other concentric rings of silk laid down, that the whole construction takes on a mathematically accurate appearance. Darwin suggested that this was automatic and not due to any particular ingenuity on the part of the spider, since, once it started upon the construction of a web, the length of its legs would limit the spacing of the threads, which, when pulled tight, would automatically give the familiar shape. Whether this is true or not is a point which is still being debated by naturalists. The amateur who has become fascinated by the spider's web should observe exactly how the spider makes it; he may then philosophize upon the theory after the practice has been fully understood.

Forming the Outline of the Web

A simple frame of loosely-woven silken material is formed by the spider stretching a horizontal thread across two neighbouring objects and allowing itself to fall from one end of the thread to a point of attachment below. It then climbs up the thread again, and, crossing to the other side of the horizontal one, drops down once more, laying down in this manner three lines of a quadrangle. In order to complete the other side, or fourth line, it climbs up the thread which was last secured and repeats the process by crossing the horizontal thread once more and dropping down the other perpendicular thread and drawing a new one after it; this completes the framework. Next, the corners are joined and the radii laid down with great exactitude.

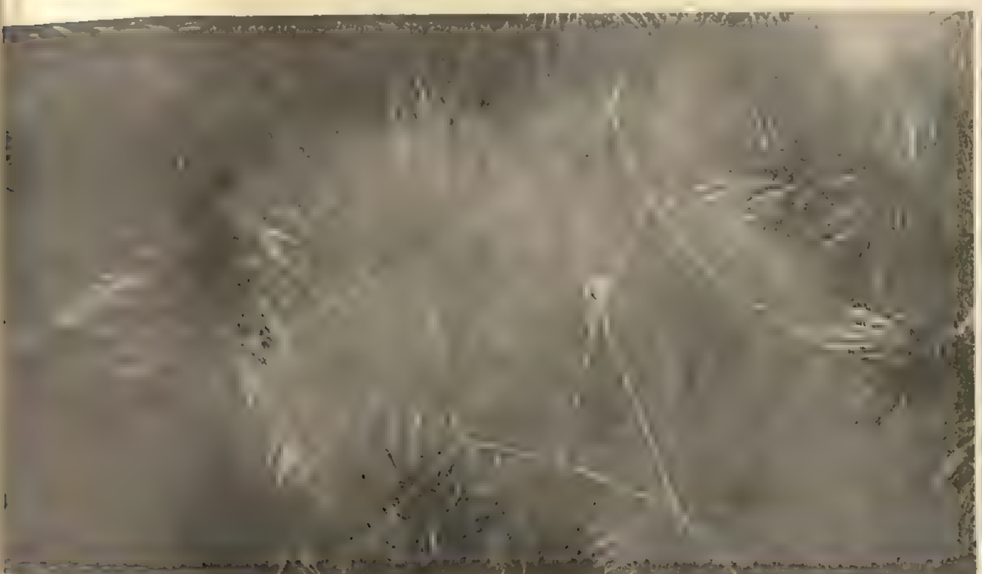
Now the process continues as follows: the spider returns to the centre of the web and, moving outwards to the circumference, forms two sets of spirals separated by a narrow gap to allow of the passage of air, the spirals crossing each radius at right angles. Having arrived at the circumference, it retraces its way to the centre, reinforcing the spirals with a thick thread of sticky silk. Now passing back from the centre to the underside of an adjoining leaf or stick, a single thread is laid down which acts as a trap line. By means of this the spider, although not actually on the web, is able to feel

WHILE OTHERS SLEEP

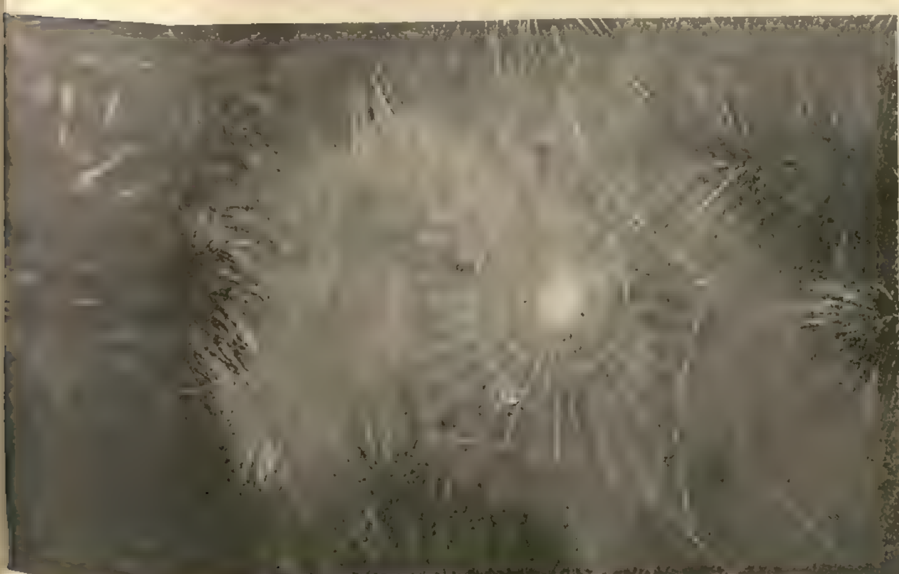
Throughout the night the garden spider works with unflagging zeal, so that with the dawn its intricate fly-trap will be in full working order. This photograph shows a garden spider laying down the communication cord which connects its hiding-place with the gossamer snare

J. J. Ward

The key diagram on the left is numbered to show the order in which the threads of a particular spider's web were laid down. The spider emits the thread from its body in the form of a liquid, which solidifies on contact with the air and adheres to the leaf or branch from which the spinning operations are begun. The picture on the right shows the spider laying down the first thread of the framework.

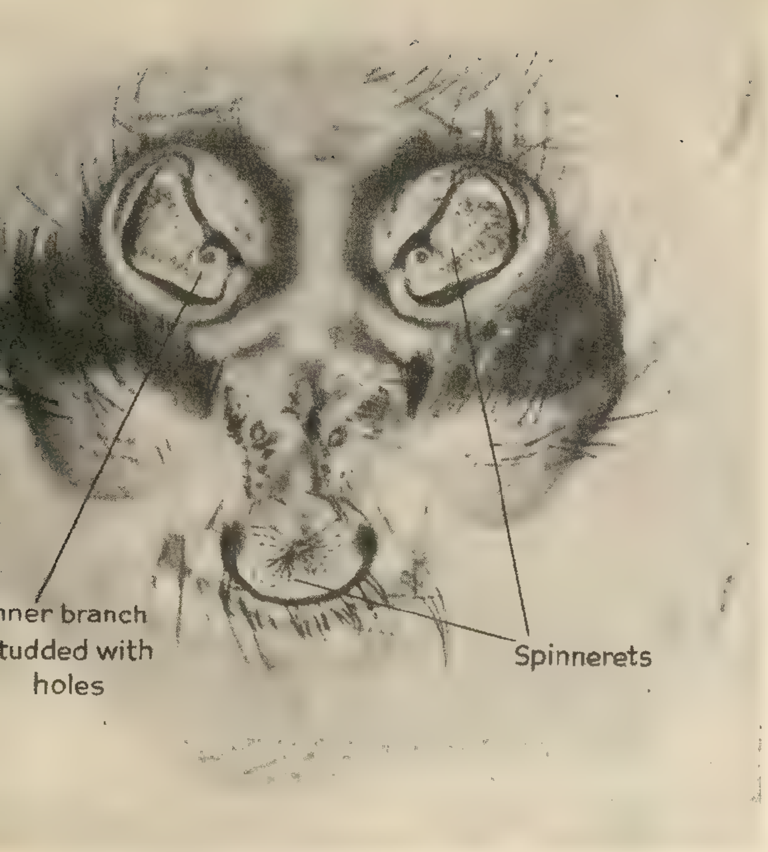


After the framework is finished and finally tested, the construction of the radii or spokes is undertaken; in the left-hand picture the spider is seen just after it has completed the first two in the series. On the right a much more advanced stage in the proceedings has been reached, for practically all the spokes have been spun into position, and the spider rests from its labours for a while in the centre.



The thread used in the construction of the spiral looks much the same as the rest of the web when it is first emitted by the spider, but on contact with the air it soon assumes a stouter appearance. A central spiral is first put in place to steady the whole construction, and then, separated by a gap to allow of the passage of wind, the outer or main spiral. The completed web is shown on the right.

THE MAKING OF A SPIDER'S WEB: A STUDY IN ORDERLY DEVELOPMENT



SPIDER SILK-FACTORY

This is no study in macabre portraiture, but a photograph (magnified about 120) of a garden spider's spinnerets—complicated organs, situated at the rear of the abdomen, and studded with minute holes, from which the silky secretions proceed.

at once if anything touches it, and so can immediately hurry along the line in order to claim its capture.

Other webs, which are formed in tunnel shape, are made by the spider walking round and round a natural tunnel in the grass or some other vegetation, and weaving a layer of silk behind it as it goes, thus leaving a tunnel in the centre. In this form tunnels are also made in the earth and lined with silk to prevent the infall of loose soil or mould. Sometimes, as with the trapdoor spider, a hinged door is made at the end of the tunnel which can be opened only from the inside, so that, once within its castle, the spider is safe against all intrusion. The silk itself from which these webs are made is composed of a very fine thread of smaller twisted filaments, and under the microscope globules may be seen at regular intervals.

Defensive Devices of the Spider

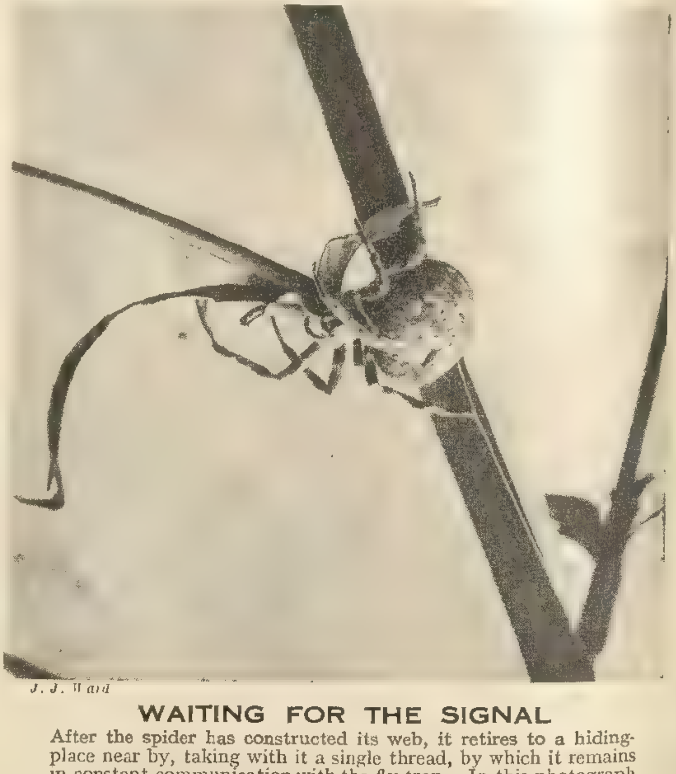
SPIDERS adopt several methods of defending themselves against foes, one of which is to spin the webs in a region where they are unlikely to be attacked, such as at a high altitude, in a waste space, on a marsh or even in the water. Mimicry plays an important part in the defences of spiders, which are often strangely coloured in order to camouflage themselves against possible attackers. The webs, too, are carefully made so as not to appear too conspicuous, leaves and bits of stick sometimes being incorporated in the construction.

Many spiders make use of their ability to spin silken threads for the protection not only of the unhatched eggs, but of the baby spiders themselves. Thus on the top of a tall grass blade may be discovered a closely-woven net of silk, which, if burst open, will reveal the swarming inhabitants of the "spider's nursery." Some species also are able to travel over great distances while still young, by clinging to thin, gossamer threads which are blown by the wind high up into the atmosphere and carried many hundreds of miles.

Aeronauts of the Upper Atmosphere

IN the nature of things it is difficult to demonstrate beyond a peradventure the actuality of such extensive voyaging, but some evidence was forthcoming recently in the course of some investigations carried out in America into the composition of the impurities in the atmosphere at high altitudes. Aeroplanes carrying special air-filters on their wings were sent up to heights of over 25,000 feet, and in several instances gossamer threads carrying baby spiders were found on the membranes of the filters when the aeroplanes landed. Since the air at high levels is always drifting in one direction or another, and a gossamer thread at 25,000 feet would take many weeks to reach the ground, it is reasonable to suppose that the distance travelled by the tiny aeronauts was very considerable. This conclusion is supported by other experiments with coloured gossamer threads which some years ago were loosed into the air and "came down" in many cases hundreds of miles away.

The power possessed by spiders of making use of the thread with which they have been provided has undoubtedly done much for these animals in the struggle for existence. Their immensely wide distribution over the face of the earth, their enormous numbers, and the great variety and number of species are ample proof of the effectiveness of what is perhaps the most extraordinary accomplishment to be found in the animal kingdom.



J. J. Ward

WAITING FOR THE SIGNAL

After the spider has constructed its web, it retires to a hiding-place near by, taking with it a single thread, by which it remains in constant communication with the fly-trap. In this photograph we see a female garden spider resting outside her snare, with her hind leg clutching the communication cord.

EASY ELEGANCE OF THE SILVAN VENUS

THE "Venus of the Woods"—such is the name by which the ash is known. Always it has been held in high esteem, and in the mythology and rural superstitions of the northern peoples it occupies a prominent place. The aesthetic and other characteristics of this much-praised tree are the subject of the pictorial analysis that follows

GRACE and beauty combined with strength make the ash one of the loveliest as well as one of the most useful of all forest trees. Few trees wear so graceful a garb as the ash when growing alone in the open park-lands or the hedgerow; few shoot up their trunks in such slender columns when they chance to flourish in the centre of a thick wood. At all times of the year it is a beautiful tree, for there is an appealing grace in the bare branches even in winter; but it is at the height of summer, when its long, light green leaves are at their best, rustling in the wind or hanging, a natural mosaic, against the blue of the sky, that the ash earns its title of "the Venus of the Woods."

THE buds of the ash make it a noticeable tree, and one that is easily recognizable, even in winter, if we examine a branch or the shoot of a young sapling growing in a hedge. The twigs are never very thin, and they are flattened in between the nodes, or leaf knobs, so that, if we cut a twig in section, there is no place where it is really round. The buds are very hard, pointed and black, two being found together on opposite sides of the stem. The bark, we notice, is pale grey, and the bole of the tree presents a rugged appearance that is at the same time very different from that of the oak or the elm; the ridges and hollows of the bark are far more regular and not so deep, while they form what may be described as a continually interlacing diamond pattern. Moreover, this roughness is not confined to the base of the tree, but runs high up, only gradually giving place to the smoother bark that clothes the smaller branches.

AS spring approaches the tree begins to take on a very different appearance. It is late when the ash really begins to find its new dress, but the sight is well worth waiting for. The leaves are very large when full-grown, being of the type known as pinnate, six or so pairs of leaflets growing on either side of a stiff midrib with a single leaflet at the end. In spring they are of a most delicate green, and the whole tree shines and shimmers in the sun and the early breeze. When the tree is in full leaf, the twigs have each a very considerable weight to bear, and in this we may find an explanation of the stoutness of their build.

In April or May the ash flowers, and although the inflorescence is a fairly obvious feature of the tree, the individual flowers are insignificant in the extreme. Devoid of both calyx and corolla, they are found in large clusters borne on a shortish stalk growing from the sides

BLACK BUDS OF THE ASH

The male flowers of the ash (seen in the picture below) appear early in the year, before the leaves have even begun to sprout. The leaf buds, black in colour and rather stout, are a recognizable feature, and the bunches of male flowers grow on very short stalks from out of the sides of the thick twigs.

H. Crawford

Dennis

WAITING FOR POLLEN

The female flowers of the ash are in sharp contrast to those of the opposite sex, especially when borne separately, as in the above photograph. The curious shape is quite characteristic, consisting of the single ovary surmounted by the pistil. Below the lower left-hand bunch the black bud scales, now burst apart, can be easily seen, though they will soon die and fall.

of the upper twigs and branches, and are seen as purple masses before the leaves appear. Male or female flowers may grow separately on different trees or in separate clusters on the same tree, and in some of the flowers both male and female organs appear. At first the clusters are purple in colour, then brownish, or greenish if only female flowers are present; the latter consist of a single pistil, yellow-green and pear-shaped, while the stamens of the male flower, two in number, are brownish-purple.

More conspicuous than the flowers are the fruits of the ash, of a type botanically known as a samara. Each fruit consists of a long, narrow, oblong scale, which encloses at the end nearest to the stem a single seed. Hanging in large bunches from the trees, the fruits are among the most characteristic objects of the countryside from midsummer onwards. They are known popularly as "keys," from their resemblance to the old-fashioned type of door key, and also as "spinners," from the spinning motion with which they sail to the ground when ripe. Examination of a fruit will reveal that the scale or wing has a decided twist to it, giving it a resemblance to one blade of an aeroplane propeller; to this it owes the spinning motion which helps it to be borne by the wind some distance from the tree, instead of dropping straight to the ground. These seeds appear only on mature trees which are at least 40 years old; the reason why many trees over that age seem to be barren is that they have no female flowers.

NAKED GRACE

The fine form of the ash is seen to better advantage in winter than in summer. This photograph shows the way in which the main trunk often divides into two, the branches running generally upwards and not outwards as in the cases of the oak and beech.

E. J. Hosking

Formerly the ash was grown deliberately as a hedgerow tree, for the fine broad boles gave solid timber of fair dimensions up to as great a height as twenty feet, and the long, often straight, branches were also of value. Such trees as these did much to beautify the countryside, besides having the additional virtues of holding the hedge-bottoms together with their roots and affording generous shade for cattle. In well-timbered districts, however, the ash may be grown as a forest tree, and it then loses much of its natural beauty. The characteristic, rather square outline of the ash of the parkland is superseded by a tall, quite straight, slim trunk, whose lower branches have died off as a result of competition in the great struggle for light and air. There is, however, a distinctive beauty about the columns of the forest ash, for they terminate, not in a thick mass of foliage, as do the conifers, but in a light, diaphanous leaf-mosaic that gives us an impression of a very delicate sunshade, held, it may be, as much as sixty feet above our heads.

Advantages of a Large Leaf

It is in such situations as the thick wood that we see the advantage of the ash tree's large leaves; when there is so much trunk to be fed, there must be the largest possible leaf surface in contact with the air in the comparatively small space available in the treetops. The way in which the leaves are divided up means that they offer far less resistance to the wind or rain than would a single entire leaf of the same surface area, a matter of vital importance in the mechanics of the tree. Finally, the ash's leaves appear late in the season, and fall earlier than those of most trees, so that in a short time it has to absorb a great deal of food-material; large leaves are again an obvious necessity in the tree's economics. It is the great size of the leaves, of course, that necessitates the stoutness of even the youngest twigs of the ash, a feature already noted.

Despite the fact that its branches do not normally come very low down, and its leaves do not make as dense a shade as those of many other trees, the ash is seldom

'QUEEN OF THE SUMMER'

By this title the ash is sometimes known, and when the wind ripples her dull-silver foliage and the sunshine on her lofty summit forms a jewelled crown, the ascription seems well-deserved.

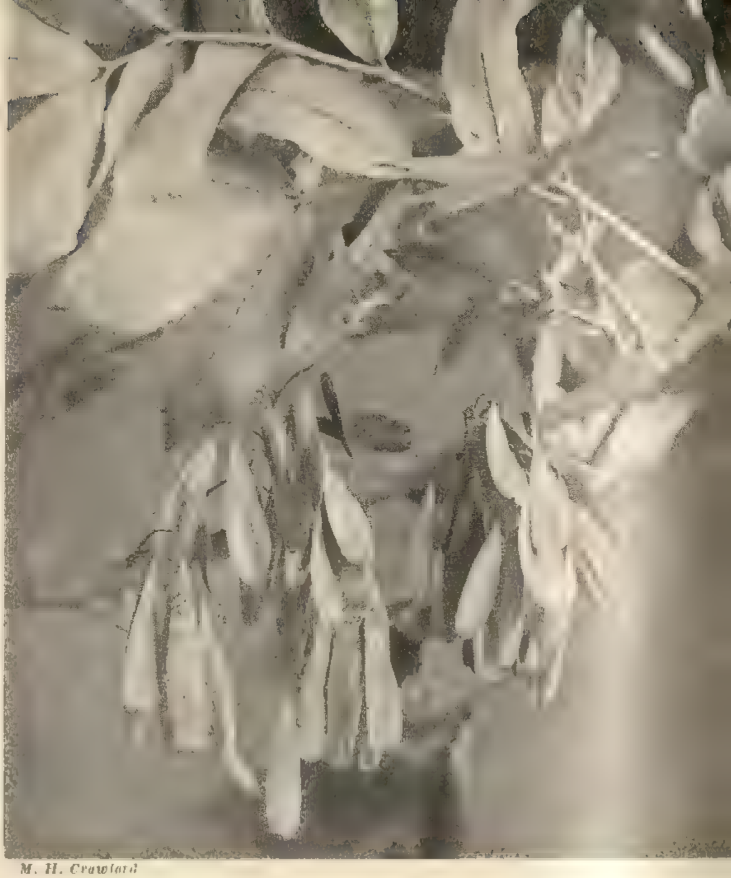
E. J. Hosking

found with much vegetation around its foot. This is not because, as the older naturalists averred, the "drip" of its leaves is poisonous, but because the tree's roots are very spreading and grow only just under the surface. In fields where cattle regularly shelter under the ash trees, the roots are often bared to the air. In the hedgerow the ash grows very rapidly, reaching a height of ten feet in two or three years, and it is from the hedgerow ashes that the "ash plant" sticks beloved of the rambler are made. These are usually imported from abroad, for the stick-making industry is not much practised in this country. The round handles are formed by bending after the wood has been rendered pliable in steam, and the knobbed sticks are made from the rootstocks, or from saplings that have been pegged down to the ground when very young.

Economic Value of Ash Timber

As a timber tree the ash has long been valuable. It was formerly used for axle-trees, in coachbuilding and in all work where lightness was required in combination with toughness, elasticity and durability. Since the advent of steel it has been far less popular, but it still finds a certain market with aeroplane constructors, and one use for which it has never been in danger of supersession is that of making oars. It is said, however, that English ash is unsuitable for this, and a great deal of the wood is imported from America and Austria.

Owing, perhaps, to its absence of association with any particular series of flowering plants and shrubs, the ash is not the home of as many insects as most of our larger trees. The caterpillars of certain moths live on its branches, and in some years they may do very great damage, almost denuding the trees of their foliage. When this happens, the trees are of necessity considerably weakened, and this is often the signal for a combined attack on the part of other insects. Amongst these may be found the ash-bark beetle, one of the scolytid or bark-boring beetles; if one sees a series of ashes that are obviously suffering severely from the ravages of caterpillars, the little beetles may be found boring into the trunk. They bore straight in through the bark, and then proceed to make a short tunnel along the wood under the bark, laying eggs at intervals along the tunnel.



M. H. Crawford

PENDENT 'KEYS'

The fruits of the ash are of the type known as a samara, already mentioned in connexion with the elm (see page 144), consisting of a seed within a largish winged body which is useful in ensuring distribution. These bunches of "keys," as they are called in the case of the ash, are a conspicuous feature of the tree in summer.

ASHEN PEDESTAL

Firm and strong, covered with the characteristic rough, grey bark, the bole of the ash is a worthy pedestal for the grand spread of branches that make the tree one of the stateliest of Britain's arboreal range. Notice in this photograph the way in which the smaller shoots have grown downwards, owing to larger branches having cramped their upward growth.

E. J. Hosking

When the grubs hatch out from these eggs, they start to bore outwards, away from the original tunnel, each along its own line, until they are full-grown, when they pupate. The following year they turn into beetles and bore their way out through the bark, thus making many more holes. Such a concentrated attack as this, combined as it may be with that of other insects and of various fungi, will in a year or two kill a tree. In every case there will be found a definite succession of insects and fungi that attacks the trees, for no one can start work until the others have prepared the way, it may be by partially rotting the wood, or perhaps by boring holes that will allow fungal spores to reach the inner tissues.

In situation, the ash shows a surprising variety of choice. The side of the purling stream, the open hedgerow, the edge of some rocky crag are all favourite haunts, for the ash is by no means a tree of the lowlands, growing even in this country at a level of 1,350 feet, and abroad running up to as much as four thousand feet.

MOTHS THAT RALLY TO A SOUNDLESS CALL

THE first two chapters in our "Butterflies and Moths" section have had for their subject certain of the more prominent and frequently-encountered members of the butterfly tribe. Below we are introduced for a change to some of the moths—the oak-eggars and their near relations. Not so brilliantly-hued as the butterflies, they display none the less many remarkable and attractive features

OFTEN in the warmer days of spring the rambler may come across an exceptionally large caterpillar, of a rich brown colour covered with long, silky hairs, and with deep velvety-black marks between the rings of its body. This is the larva of the oak-eggar moth, one of the finest and commonest of our moths, and one of the most interesting. The oak-eggar is particularly easy to breed, and if the caterpillar is taken home and fed on bramble, heather, hawthorn or some of the many other low-growing plants, it will in due course grow to its full length of four inches or more, and then spin a cocoon. This cocoon is rounded and oblong, very hard and strong, and covered with a number of silk strands, with which it is sometimes woven to the food plant. The caterpillar is full-grown by the end of June or early in July, and specimens found wandering at that time are usually already on the look-out for a suitable place for pupation, and in an ideal stage for collecting and taking home.

Within the cocoon the caterpillar turns into a pupa or chrysalis in the normal way, and after a few weeks in this state the perfect insect breaks open the top of the cocoon and makes its way out. The future history of the adult moth varies greatly according to whether it is a male or a female. In July and August one may sometimes see a large, dark brown moth flying at a great speed—so fast, in fact, that in open country there is little chance of catching it. This is the male oak-eggar, and he is hurrying to keep tryst with a female whom he has never yet seen. In watching the flight of this moth, so direct and steadfast, so very different from that of other moths as they hover over the sweet-scented flowers of the garden, one is witnessing only another of the marvels of Nature: this is the process known in entomological parlance as "assembling."

Bride Scented Mile Away

THE moth is flying in response to the attractions of a moth that may be a mile or more away, and with nothing better to guide it than a wind-borne scent far too subtle for the human organ to detect. If we examine a male of the oak-eggar, we notice that the antennae are of a type known as pectinated (Lat. *pecten*, comb), being, in fact, like a very fine double comb. Borne on these highly-developed antennae are special sense organs with which the male picks up the scent emitted by the female: this scent can, of course, reach only males that are down-wind, and for that reason the males that are seen on this rapid flight are always moving up-wind.

Many a young collector, having successfully reared the female oak-eggar from the larval stage, must have been greatly surprised when one day, for no apparent reason, he found the room in which the female was kept in her breeding cage swarming with male moths. These migrants come from a very long distance, drawn by the female's scent, and so long as she remains unfertilized they will go on arriving, until perhaps two dozen of them are dashing wildly round the room, beating against the cage with their wings, fluttering all over the sides and roof. But as soon as one insect is admitted to the female hanging quivering from the roof of the cage, with her antennae vibrating all the time, she ceases to give out "messages," and the disappointed lovers disperse, perhaps in answer to the call of some other female of the tribe.

FOR many years this phenomenon of "assembling," found in many other moths related to the oak-eggar, was the subject of much controversy among entomologists in all parts of the world. Even now it is not wholly elucidated, but the idea that it is due to very high development of the organs of smell is generally accepted. If one is fortunate enough to rear a female oak-eggar, it is best, as soon as possible after she has emerged from the

Ward

FURRY GOURMANDS

The caterpillars of the oak-eggar moth, two of which are seen here, are most voracious feeders, quickly stripping a twig of its greenery. They are covered with rich brown hair, with white splashes on the flanks. (About natural size.)

Ward

SILKEN SHEATHS

Inside these strong-walled cocoons the caterpillars of the oak-eggar change into chrysalids, from which in due course the moths themselves will emerge. The particular cocoons shown here are among the leaves of the hawthorn, but as often as not they are to be found among grass stems on the ground. (× 1½.)

pupa, to take her out into the open country, where there is more chance of attracting a large number of males. With certain of the rarer moths of the group this is used as a method of securing specimens of the male insect.

When the female has been fertilized she flies away, laying her eggs as she goes, and dropping them one by one at intervals. These small eggs laid in this way are invisible to all their enemies, and so there is no need for the moth to lay them for safety's sake on the undersides of leaves. On the other hand, there must be many eggs that fall in places where there is no suitable food and where the little caterpillar has no chance of surviving. In this way Nature adjusts the balance that is upset by the unlikelihood of enemies finding the eggs.

In colour the oak-eggar is brown, the male being extremely dark, with a yellow band across the outer part of the wings; this band is very definite on its inner edge, and shades rather delicately outwards. In the centre of the fore-wings there is a yellow spot. The females, which are much larger, have a far lighter colour scheme, so light that the band of colour may be scarcely visible at all; the outer parts of the wings are in general rather lighter than the inner areas.

Sippers of the Morning Dew

ANOTHER member of this family of common occurrence in England is the drinker moth, so called from the habit which the caterpillar has of sipping the drops of dew on long grass. These caterpillars, frequently found in spring, feed on the coarse, rough-edged grasses of the marshlands and damp hedge-sides. The colour of the body is actually greyish with yellow stripes, but this tends to be obscured by the tufts of brown hairs. On each segment of the body there are two white spots on either side; there is a spike of hair at the head end, and a longer, conspicuous tuft towards the tail. The grasses on which these larvae feed are extremely tough and hard, being sharp enough and rough enough at the edges to cut the hand deeply if they are pulled up without care; yet the drinker feeds on them with avidity. When it is full-grown, about the middle of June, it weaves on the blade of grass a brownish cocoon, inside which it pupates. The moth hatches out in July; it is brownish yellow with, at times, a definite reddish tinge, and of a shape which is unmistakable. The fore-wings come to a point, making almost exactly a right angle, and from this there runs inwards, diagonally to the rear margin, a dark line. Above this, in the fore area of the front wings, there are two paler yellow spots. The females are lighter in colour and considerably larger than the males. The moths of both sexes may be seen flying in the evenings or at rest during the daytime on grass and reed stems in their damp haunts.

Other Bearers of the Eggar Name

SEVERAL other moths bearing the name of eggar are found in the British Isles, these being the pale oak-eggar, the small eggar, and the grass-eggar. The first of these is a small moth having a wing-span of little over an inch. The male is yellow-brown with an irregular band of darker brown across the fore-wings, while the female is greyish with a similar dark band. The caterpillars live on sloe or hawthorn, and are hairy, blackish above and grey on the sides. This insect is common only in the south of England. The small eggar is brownish, the scales covering the wings thinly, so that they are semi-transparent. The male is darker than the female. In both sexes there is a white line running across fore and hind wings, a white spot inside it, and a whitish marking running outwards from the base of the fore-wing. The

Ward

CALLING A MATE

Having emerged from her cocoon, the female oak-eggar climbs up some convenient plant, and, hanging there, sends out in some not yet fully understood way messages which find a response in the shape of the arrival from afar of a number of males of the species, each eager to be her chosen spouse. (× 1½.)

male is about an inch, the female an inch and a quarter, across the wings. The caterpillars of this moth live in companies in the same manner as those of its near relative, the lackey moth, which is described in a later chapter. The grass-eggar, which is best described as a slightly smaller, yellower form of the oak-eggar, with the wings of almost uniform colour, is found on the coast of Kent, Sussex, and the other southern counties and in Lancashire and Cheshire, as well as in the New Forest.

All these insects belong to a family known as the *Lasiocampidae*, another member of which is the fox moth. Its caterpillars are black, but are so thickly covered with reddish hairs that they appear to be of an almost uniform brown colour. In the natural state they finish feeding in October, the food plants being heather and grasses, and hibernate until the following spring, when they feed-up on any warm days, and pupate in a cocoon that is woven near the ground among the stems of the food plants. The moths hatch out in the early summer, the males being often seen dashing about in the sunshine late in the afternoon. In appearance they are like smaller oak-eggars, but considerably lighter in colour; the general colour, in fact, is a warm tawny brown, with two lighter lines across the fore-wings from margin to margin. Although great numbers of caterpillars may be seen in the autumn, there scarcely ever seems to be a glut of adults in the following summer. If the larvae are collected in the autumn and kept in a box throughout the winter, they seem mostly to die off for no apparent reason, and this may happen in the natural state.

Ward

'DRINKER' CATERPILLARS

The three pictures in this page illustrate the life history of the drinker moth—so-called not because of any exceptional tippling propensity that it displays, but because the caterpillar is credited with a love of the dew-drops that glitter on the grasses in the early morning. (Natural size.)

Ward

BLADE-LIKE COCOONS

Drinker moth caterpillars feed on hard, tough grass blades, and it is to such that the cocoons seen in this photo are attached. The resemblance of the cocoons to the grass-blades is even more marked in Nature than in the photo, for their colour blends admirably with that of the grass, no longer green but yellowed by summer's heat. (× 1¼.)

Ward

IN FULL MATURITY

The drinker moths of both sexes are fine insects, differing slightly in size and colour, their brown hues and the marking of the wings making them hard to see when they are at rest among the grass. The wonderfully pectinated antennae of the male the upper of the two are particularly noticeable in this photograph. (× 1¼.)

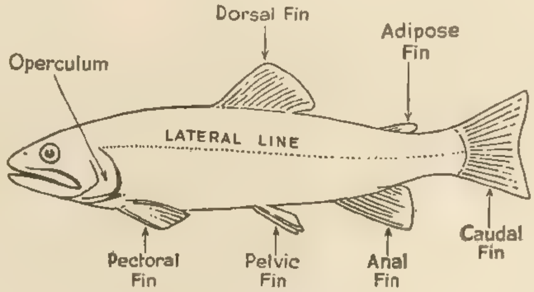
OUR SEA-FISH IN GENERAL: AND THE PLAICE

THE fish of Britain's rivers and lakes are the subject of a separate section in this work. Below is the first chapter of the series in which all the principal sea-fish that are to be found within a few miles of our shores are described and pictured. After some information of an introductory nature, the plaice, one of the most important food-fishes, is described

THE fishes of the ocean and seas washing the shores of Britain are the raw material of a great industry, and the source of a very considerable proportion of the nation's food supply. Week after week throughout the year men of the true, old seafaring type leave the ports that dot our coastline and, often in danger and always in discomfort, reap with trawl and drift net and line the harvest of the sea. Over the shallows of the continental shelf, the Dogger Bank in particular; off the Atlantic coasts of Scotland, in the Irish Sea and the English Channel, far to the south-west beyond the Scillies and farther still to the north in the waters that separate Iceland and the Faroes from the Arctic continent—in all the surrounding seas and oceans the hardy fisherfolk pursue their venturesome, very necessary, but not always sufficiently appreciated or well-rewarded calling.

British sea-fisheries make a fascinating subject of study, but in this series of chapters we are concerned only incidentally with the fishing industry. Primarily our concern is with the industry's raw material—the fish themselves.

In the history of evolution the fish forms an extremely interesting link between the simple, jellied, boneless forms from which all life originally sprang and the highly complex, backboned, or vertebrate, land-living animals, of which Man is the most perfect species. It was while life was still limited to a watery existence that the formation of an inside skeleton came into being. In the fish to be found in the oceans today we can trace the history of the development of this skeleton and the origin of the backbone. Bone is an adaptation of cartilage, and some of the simpler forms of fishes are still without any proper bones, relying entirely upon a cartilaginous skeleton for the maintenance of rigidity. Examples of these types of fish are the sharks, their small cousins the dogfish, the skates and the rays.



TYPICAL FISH IN OUTLINE

Fish are of two kinds: bony and cartilaginous. This generalized diagram shows the main features of a bony fish. In the cartilaginous fishes there are no gill-covers and the mouth is differently placed, while many bony fishes vary considerably in the placing and number of their fins.

Blood-corpuscles of the Fish

ALL fish are cold-blooded, that is their temperature is that of the surrounding water. With the exception of the eel larvae and the lancelet (Amphioxus) they are all red-blooded, the colour, as in the higher animals, being due to the presence of the red blood-corpuscles coloured with haemoglobin. These corpuscles in fish are oval or elliptical in shape, with the single exception of lampreys, in which they are circular and flat.

Respiration in fishes is carried out by means of the gills, which vary greatly in structure and covering. In them the blood pumped by means of the heart through the arteries and veins of the fish comes into close contact with the sea water, in which large quantities of air have been dissolved. Through close contact the corpuscles of the blood are able to absorb the oxygen in this air and to carry it throughout the body of the fish. In the bony fishes (*Teleosteans*) the gills are supported by bone structures, but in the cartilaginous species (*Elasmobranchii*) the gills are hidden within the body, appearing only as small slits, or gill clefts, at the side of the head; these number five, and in some sharks, six or seven.

THE shape of a typical fish such as the herring or the salmon is too well known to require description, but even among the commonest types there are very great variations, as can be seen from a comparison of the cod and the dab or the sole and the herring. These variations, as much as anything else, make the study of fish a fascinating subject. It is, however, necessary, before embarking upon a description of any one of these species to have some standard by which they can be easily judged and compared. We give in this page, therefore, a drawing of a typical bony fish, showing the parts of its body and its fins.

One of the most interesting features of the fish is the presence of lines along the side of practically every species. These consist of a series of almost microscopic openings to be found arranged in a line midway between the dorsal and pelvic fins. If one of these little cavities be cut open, it will be found to contain a tightly-packed jelly-like substance. This jelly comes into close contact with the end of a nerve, and physiologists are of the opinion that the lateral lines are nothing more than rows of simple "ears," or organs for the reception of vibrations in the water. It is also suggested that by means of the lateral lines the fish are able to determine their distance from the surface by the degree of pressure which the water exerts upon the jelly-like substance within the cavities.

From a glance at the diagram of a typical fish we might be led to believe that the dogfish and the mackerel were much more closely allied than the mackerel and such a flat-fish as the plaice. This, however, is not so,

Ward

LOWLY LANCELET

The lancelet, known to scientists as *Amphioxus lanceolatus*, is one of the lowest vertebrates, having a cartilaginous internal structure but no skull. It has a length of just under two inches and is found burrowing in the sand on our shores. It is questionable whether it is primitive or a degenerate form.

for the difference between the mackerel and the plaice is not nearly as great as at first appears; the plaice's peculiar shape is due to its delight in feeding on the bottom and to its sluggish habits, which make it "sleep where it dines." Thus, through countless years, the plaice has gradually assumed a flattened shape; its eyes are both on the upper surface, and its mouth has been twisted round. And yet the resemblance of the plaice to the ordinary bony fish can be traced in the life history of the young, for the baby plaice hatch out as normal fish and only gradually assume the flattened shape of the true adult plaice.

THE female plaice produces about a quarter of a million eggs, in groups of a thousand or so, one at a time. This procedure is necessitated by the great size of the eggs, which, ripening inside the body of the fish, become filled with a very light fluid before extrusion and are in this way much enlarged. This fluid is literally forced into the eggs, which, as soon as they leave the body of the female fish, float freely in the water and are carried by currents to all parts of the ocean. The process of extrusion usually takes about two weeks, but sometimes as many as three or four prove to be necessary. The male plaice fertilizes the eggs as soon as they are freed into the water; very few indeed ever escape impregnation under normal conditions, and unfertilized eggs are very seldom, if ever, to be found in either the North Sea or the Atlantic. The time required for the development of the eggs varies with the temperature of the water. An experiment has shown that eggs fertilized in January at Dunbar took from sixteen to seventeen days, while those hatched out in April required a maximum of nine days before the larvae appeared in any large numbers.

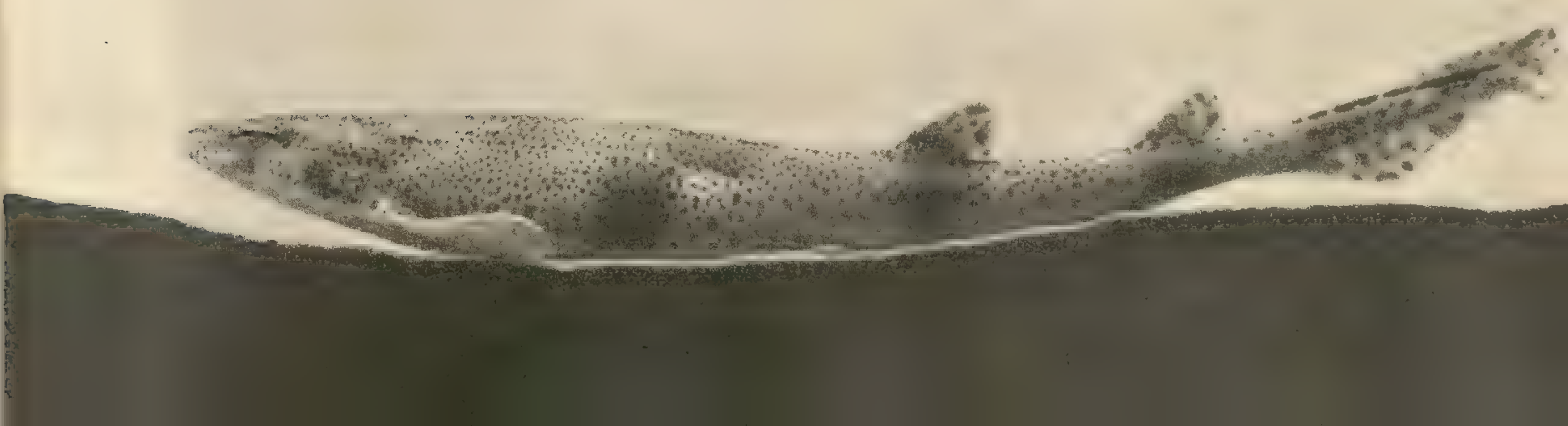
As is usual with fish, the young larvae rely for some time on the food stored up in the yolk-sac, which disappears after about eight days. It is following this that the change from the symmetrical to the asymmetrical body takes place, and that the remarkable development of the adult from the more normal-looking larva may be observed.

Berridge

ONE OF THE TRUE FISH

The mackerel is typical of the true fish. Note the scales, gill-covering, placing of fins, the broad, evenly-developed tail and the pronounced lateral line. The mackerel has a complete bony skeleton and ossified skull, and may be regarded as one of the highest forms of the typical fish.

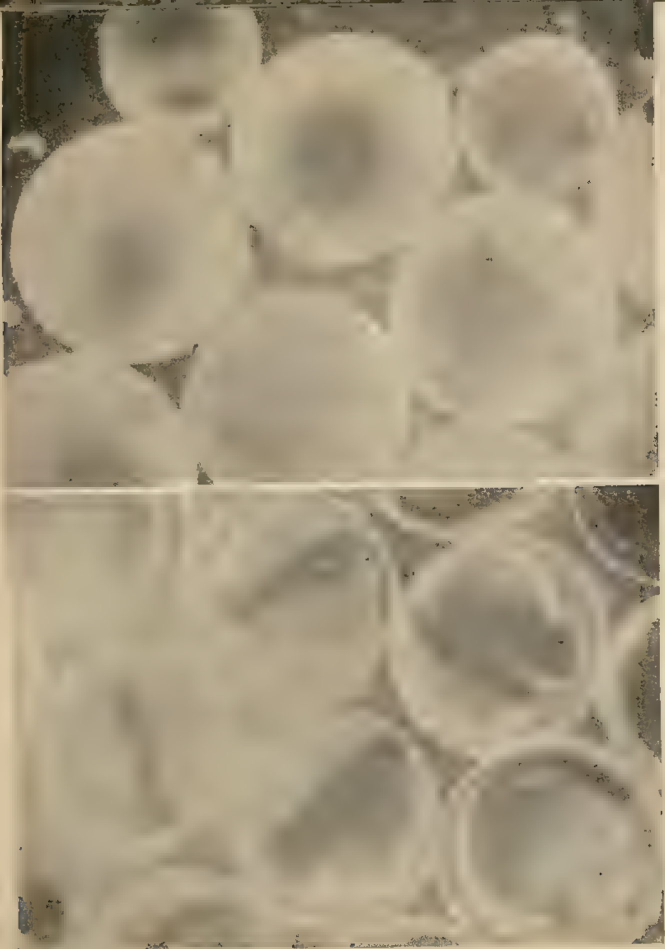
It should be noted that according to the usual procedure phylogenetic or racial changes are repeated in the embryo's development, and only the specific and particular changes take place during the larval or immature stages of development.



Bond

NEARER THE PRIMAL STOCK

The wicked-looking dogfish is included in a sub-class of fishes together with the skates, rays and sharks. Note the placing of the fins, the separate gill-openings and the uneven tail. The skin is much rougher than in ordinary fish, and the skeleton and skull are cartilaginous



Martin Duncan

EGGS OF THE PLAICE

No one would suspect from the appearance of a plaice's egg that it would hatch out anything unusual. These photographs show (greatly magnified) the egg in two stages of its development, the lower picture revealing the embryo taking shape. The period of incubation is usually about twelve days.

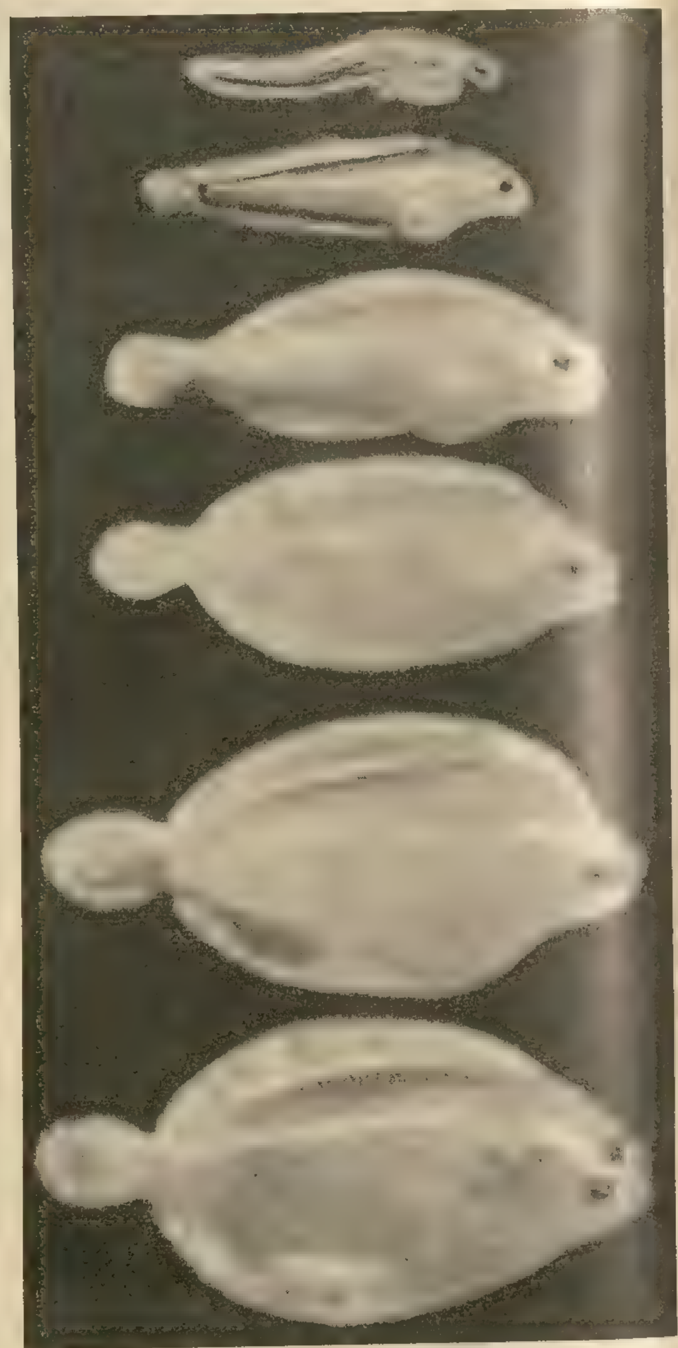
It is now that the plaice begins for the first time to take external food, which is, of course, of microscopic dimensions, consisting mostly of such pelagic forms as diatoms and the larvae of shellfish. The growth of the young fish is somewhat slow, and even after twenty days from the date of hatching it is only three-eighths of an inch in length. After this the length increases even more slowly, but a very considerable growth in height is to be observed. Small crustaceans are now eaten in large quantities and the young fish swim ever farther and farther from the region of their birth. The tail begins to be bent up at the tip and the fin rays appear on the ventral surface, but even at this stage, as many as thirty days after hatching, the plaice is still symmetrical.

Changes in the Eye Position

Now begins the change in the position of the eyes. The left eye moves upwards and forwards; ten days later it appears on the upper margin of the head, just in front of the right eye, and on the forty-fifth day after hatching it attains its final position, namely, above and in front of the right eye. While the eyes are going through this rotating movement the young fish begins to take up a new position when swimming. The whole anatomy of the body has in reality been subjected to a distinct twisting process, and the fully developed fish finally swims and lies upon the sand of the bottom on what is really its left side. Small crustaceans called copepods are now eaten in large quantities, as well as the larvae of molluscs and other crustacean denizens of the deep.

After the completion of the process of metamorphosis the fish change their food once again and depend almost entirely upon various annelid worms and many types of crustacea. In time the adult food is sought for, and cockles and mussels are destroyed in thousands by the ravages of but a single plaice.

Experiments designed to discover the general movements of the plaice caught in the great fishing grounds around our coasts have been carried out by marking fish taken in a certain area and then throwing them back into the sea. When a fisherman catches a plaice with a



Berridge

PLAICE METAMORPHOSIS

This series of photographs shows how the plaice changes from the normal form to the flattened shape of the adult. Note how the eye on the left side gradually moves across the head and over to the top side. The yolk-sac may be observed in the early stages.

IN SPOTTED MATURITY

The adult plaice is excellently adapted for its life upon the sea bottom. Not only has the left eye swivelled over to the upper side, but the skin has become spotted. The use of these spots becomes apparent when the fish lies upon sand, where its variegated colouring makes it almost invisible.

mark on it he is rewarded if he sends the fish complete with the attached disk to the local depôt of the fisheries investigation department, together with a full account of the particulars and date of its capture. The locality and the date when the fish was thrown back into the water after the first capture are marked on the brass disk, so that in this way the distance travelled and the time taken to cover it are easily and accurately recorded.

For many years now these experiments have been going on, and the fishermen, as a general rule, return the fish quite willingly as soon as they are caught. In the early days of the investigations they were, however, often unwilling to do so, fearing that restrictive measures might be passed by the Government as a result. Sometimes the labels are returned without the fish, and it is on record that in one case the forwarded label bore distinct evidence of having been in the frying-pan!

Through these investigations it has been shown that the larger the fish the wider is its area of migration. On the whole, however, the plaice is undoubtedly a sedentary animal, although there is abundant evidence that the fish can undertake very considerable journeys. Plaice liberated off Blackpool, for instance, were caught six months later off the Irish coast, which meant that they had covered more than 130 miles in that time, or more than twenty miles a month. In one case the same plaice was caught three times in as many months—at Morecambe Bay, in Barrow Channel and at Fleetwood. One fish marked and liberated in the North Sea in 1904 was not recaptured until 1920, when it was found only a few miles from where it was released sixteen years before.

SEA FISHING FOR AMATEURS

Sea fishing is a sport which may be enjoyed without much expense by any visitor to the seaside. The least expensive way for the novice is, of course, to wield a bamboo-cane to which are attached a long line, a hook and a piece of suet or other suitable bait. To those who wish to fish just once or twice for the fun of the thing this is quite sufficient. Sea-fish are inquisitive creatures and voracious feeders, and some large fish may easily take an amateurish bait in preference to the lures of more expert anglers.

But if this form of sport has been tried and the desire to catch fish is still strong, the angler should go farther afield in search of his prey. The next step should be that of employing a competent boatman who knows the fishing grounds in order to make sure of learning the localities where fish abound. Probably the novice will start with a hand line, when he must wait patiently while the boat is rowed along or else rocks at anchor. The mere action of holding the line will be sufficient to check the line when the fish bites, and so there is no need to strike as with rod and line. Once the fish is hooked the line may be pulled in and the fish hauled into the boat.

Some Things to Learn

At first this sounds but a dull performance, but there is much for the novice to learn. There is the difference between bottom fishing and fishing for the more sporting denizens of the sea. Then there is much to be learned of the localities and seasons of the different fish, and what bait each prefers. There is much technical information to be absorbed concerning the different kinds of tackle and their right use, the size of boats and the strength of gut and line. Perhaps one day it may be possible to go in pursuit of tunny; then expert assistance must be sought, for tunny fishing is a hazardous business, and to go in search of the most important of our game fish unprepared would be rank folly.

Much else may be picked up in this pursuit of sea fishing. If the fisherman is informative—a friendly glass or two of beer at the local inn will probably thaw his aloofness—much local history may be gleaned. Gradually the mysteries of weather will be revealed, and the portents of the sky become obvious.

INTIMATE PEEPS INTO A DROP OF POND WATER

Just a drop of pond water—but placed on the microscope slide it is revealed as a world in miniature, inhabited by a multitude of varied creatures, hurrying hither and thither—impelled, it seems, by the same primitive instincts as move the creatures in the world brought into our ken by the naked eye

Our earth is teeming with unseen life. In hedgerows, in ditches, in pond and stream, upon blades of grass and in the bodies of animals, live the minute animals and plants whose millions pass unnoticed by the ordinary observer—yet, perhaps, not quite unnoticed. Sometimes stagnant pools, particularly those in peaty country, show an iridescence upon their surface similar to the rainbow colouring that can be seen where petrol has been spilled upon a wet roadway. This iridescence is caused by millions of minute, unicellular forms of vegetable life called *diatoms*, whose bulk tints the water. Similarly, phosphorescence in the sea is caused by the presence of numerous protozoa.

It is an easy matter to convince oneself of the reality of this unseen world. A drop of pond water, placed upon a slide and examined under the microscope, will yield a rich harvest of minute animals to the field-naturalist. Small transparent and semi-transparent animals will cross the " field," some moving slowly, apparently feeling their way, others crossing and re-crossing as though they were in a continual hurry. There are so many varied types and species that it would be impossible to describe even a small proportion of them here, but we may give a short account of some of the varieties that are commonly seen.

First, there are the protozoa (Gr. *protos*, first ; *zoon*, animal), which were mentioned in the introductory chapter of this series (page 73). This great class, which stands at the bottom of the animal kingdom, is entirely made up of small, unicellular animals. Some idea of their wide range and variety may be obtained when it is realized that one group alone, the *Foraminifera* (Latin, *foramen*, small hole ; *ferre*, to bear), which have calcareous shells, form vast deposits of ooze at the bottom of the ocean—deposits which may, in the far distant future, be raised up to form cliffs and escarpments similar to our own chalk downs. Another group, the *Radiolaria* (Latin, *radiolus*, diminutive of *radius*, ray), have flinty shells, while many protozoa have no shells at all, e.g. amoeba.

Some live in decaying matter, or as parasites, the *sporozoa* ; others may cause disease, as does one variety of amoeba that is the cause of dysentery ; while some may even live within the animal yet aid the process of digestion of the host, as in the case of the protozoon *opalina* inside the frog.

To return to our drop of water waiting upon the slide. We are almost certain to see amoeba, the animal which is most generally used as the type specimen of this class, and which was described in detail in the last chapter. It is

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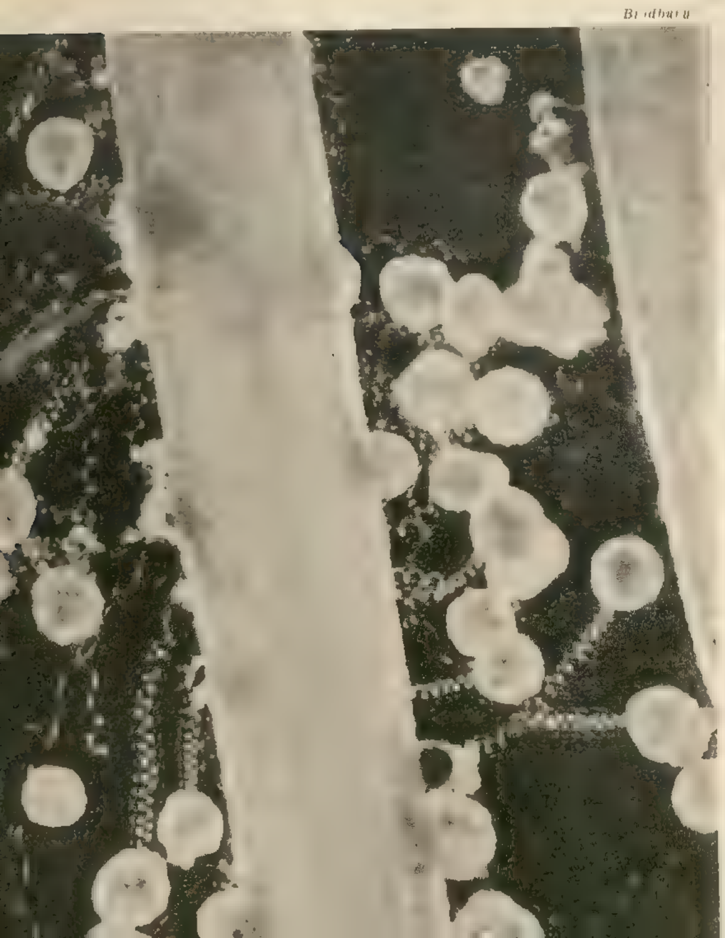


ANCHORED ANIMALS

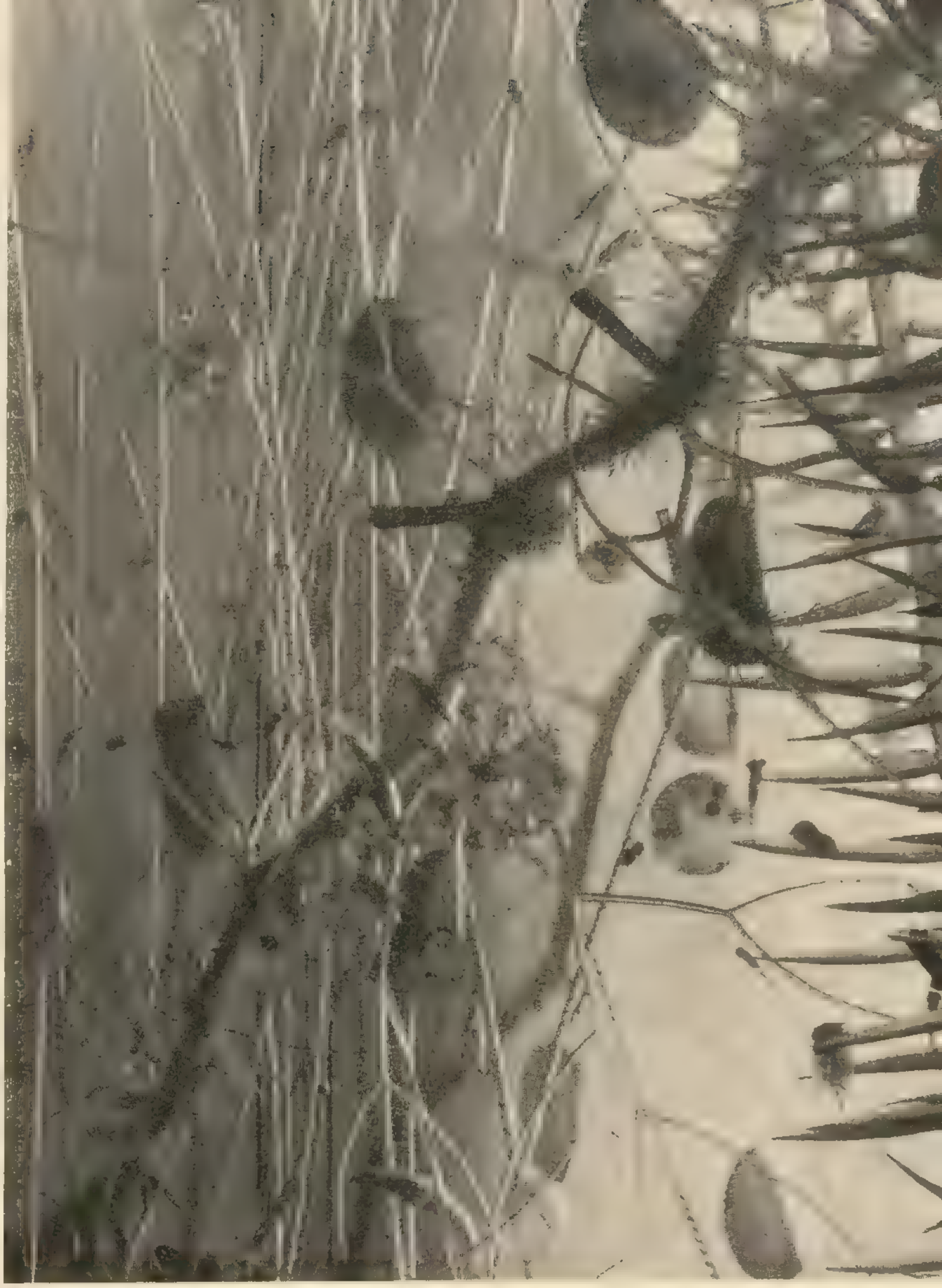
Vorticella, sometimes known as the bell animalcule, on account of its shape, resembles a plant in that it is attached to some solid object by a stem. Left, a colony of vorticella (× 100), and below, two specimens under high power (× 400). Note the bands of cilia and the retractile stems.

Cheazin

wise to try and identify amoeba first of all and recognize its various parts, the protoplasm, nucleus, pseudopodia, and contractile vacuole. Once this has been done, it is a comparatively simple matter to pick out from amongst the many other forms of life those that belong to the protozoa.

AMOEBA (page 74) is a representative of those protozoa possessing pseudopodia and capable of crawling along by means of them, but these unicellular animals are not all alike. There is one group in which the animals propel themselves through the water by means of minute, hair-like threads, or cilia, the vibrations of which set up currents in the water and aid the minute animal in its progress.

Typical amongst the *Ciliata* is *paramoecium*, sometimes called the slipper animalcule on account of its shape. Unlike amoeba, paramoecium cannot change its form or protrude its pseudopodia, as it is enclosed in a thin covering or pellicle; nor can it, therefore, feed as does amoeba, by absorbing any matter with which it comes in contact. It feeds, instead, by absorbing nutriment through a small gullet, the food particles being brought there by the water currents set up by the cilia that line the approach. Paramoecium also differs from amoeba in having two nuclei instead of one, the *meganucleus* and the *micronucleus* (Gr. *megas*, large; and *micros*, small). Reproduction is effected by binary fission, in which the animal, nuclei included, splits in two. This method of reproduction can be carried out again and again, though on occasions two paramoecia may unite again, or conjugate, to form one animal.

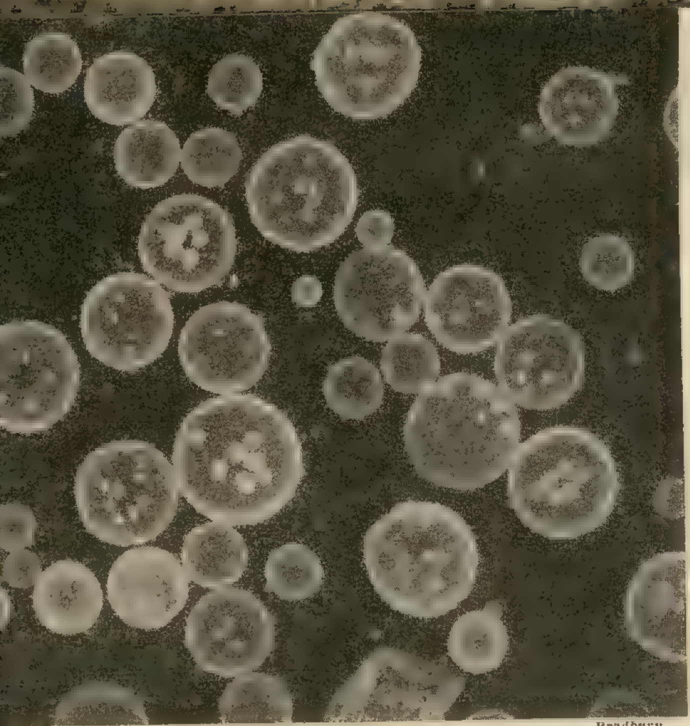


AS THEY SEE IT

In this large-scale glass model, made for the American Museum of Natural History, New York, pond life is presented as it appears to the creatures in the pond. Here are water thyme, spirogyra, or the filamentous alga, a globe of volvox, the bladderwort and small crustacea, the whole being prepared with scientific accuracy.

IT is nearly always easy to recognize one of the ciliates under the microscope from the rapid movement of their small, hair-like cilia disturbing the water, but there is one form, *vorticella*, commonly found in ponds, which might be mistaken by the uninitiated for a water plant or weed. Vorticella is a bell-shaped protozoon possessing a long stalk or stem, by which it attaches itself to water weeds or some other object, thus resembling plant life. It may occur singly, but is often found in colonies, a fact which adds to its confusing resemblance to the vegetable world. When first seen, the bell animalcule will usually have its stalk extended, but, if touched, the stalk will contract spirally. A careful examination will show that vorticella is a true protozoon, despite its deceptive appearance, for it possesses nucleus, contractile vacuole and cilia. It reproduces, as is usual, by binary fission, one of the halves becoming detached and leading a free-swimming life until it settles down and grows a stalk. Sometimes this method of reproduction is modified and the division is not equal, one portion forming a small bud, or, again, the animal may grow a number of small buds.

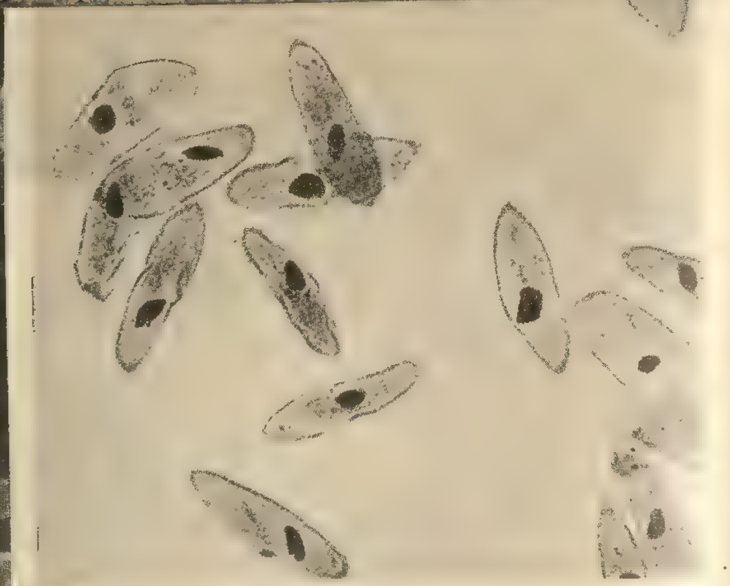
FROM vorticella we come to a small protozoon which also has affinities with the plant world, but in a different way from the bell animalcule. This small animal, known as *euglena*, belongs to the group known as *Flagellata* on account of the long, thread-like appendage (Lat. *flagellum*, whip) which serves to propel the animal through the water, and which takes the place of cilia. Euglena is free-moving—indeed, it travels about with extraordinary swiftness—and it is green in colour. This



Bradbury

INY COLONISTS

Volvox globator is a sphere of colonial protozoa and it may be seen easily under low power. This photograph (× 20) discloses a number of such colonies shown up against a dark ground illumination. A more highly magnified photograph is in page 74.



INFUSORIAL SPECKS

Paramoecium (× 130) is a typical free-swimming, ciliate protozoon. Note the dark meganucleus and the characteristic shape, which has given it the name of the slipper animalcule. An even higher magnification is necessary in order to distinguish clearly the individual cilia.

green colouring is due to the presence of chlorophyll, a substance which is characteristic of plants. It feeds, too, like a plant, decomposing the carbon dioxide dissolved in the water, assimilating the carbon and evolving the oxygen. Another of its peculiarities, and one which helps the naturalist to identify it, is the presence of a small red spot, which is supposed to be a rudimentary form of light-perceiving organ. Euglena also reproduces by binary fission as a rule, though occasionally by multiple fission, and it may, on occasion, conjugate.

THE variety of habits exhibited by even one species is so wide that it is not surprising to find colonial forms among the protozoa. The commonest form found in ponds is also a flagellate, named *volvox*. In this animal colony all the individual flagellates unite to form a spherical mass that revolves slowly in the water. These colonies often reproduce by means of two different types of cells which bud off the parent colony and then conjugate to grow into a fresh colony, a method that shows an early form of sexual differentiation. In some forms of volvox, daughter colonies may be seen growing within the parent body (*see* page 74).

If a careful watch is kept upon the microscopic creatures they can soon be differentiated. First, it is necessary to distinguish between animal and plant life, then between the protozoa and the other animals. Once this has been done, it is comparatively easy to pick out the various groups, such as the ciliates and flagellates. After a little practice the microscopist will come to a full realization of the unseen world that exists around us.

Revealers of Nature. 6

JULIAN HUXLEY

THE family of Huxley has provided, over three generations, a number of "revealers of Nature"—Nature both human and wild. Julian Sorell Huxley is the brother of the novelist and critic, Aldous Huxley, son of the famous literary critic and biographer of Darwin, Leonard Huxley, and grandson of the great Thomas H. Huxley, the foremost champion of Darwin and one of the ablest controversialists of the Victorian era. The revelations of Julian Huxley are, however, on a wider and deeper scale than the Nature-notes, say, of White of Selborne or Izaak Walton; his field of research is not restricted to the observable habits and actions of birds (although one of his chief recreations is bird-watching), beasts and insects, but he takes all Nature—from the unicellular amoeba to the marvellous mind of Man—as his province; his observations are made not in the hedgerows and chalk-pits, but in the laboratory. In this he differs from the majority of modern scientists who are content to confine themselves to some specialized branch of the great subject of biology, such as biochemistry, physiology, or comparative anatomy, or else to specialize upon some particular group of animals. That Biology is at once a more valuable and more interesting pursuit than any of its particular, now generally segregated, branches is undeniable. The discoveries and arguments of such scientists as Huxley are not to be dismissed as "theoretical" and "out of touch with existence" by the rambler or field-naturalist, to whom the question, for instance, of the inheritability of acquired characteristics may seem of little moment, yet whose own observations in the fields and woods may help to solve that baffling and hotly-debated problem.

Julian Huxley was born in 1887, and from Eton, where he was a King's scholar, passed to Balliol College, Oxford, where he was Newdigate prizeman in 1908 and became lecturer in zoology in 1910. He held scientific appointments in Texas, U.S.A., from 1912 to 1916, and after the First Great War returned to Oxford. Thence he moved to King's College, London, as professor of zoology, and next to the Royal Institution, where he was Fullerian professor of physiology. He was secretary of the Zoological Society of London, 1935–42, and Director-General U.N.E.S.C.O., 1946–48.

Meanwhile he had become known throughout the world for his published works, being among the few scientists who, like J. B. S. Haldane and others, have made science "front-page news" by their work in popularizing it through books, newspaper articles, and broadcast talks. Huxley collaborated with Haldane in "Animal Biology," published in 1927, and with H. G. Wells and G. P. Wells in their epoch-making "Science of Life," 1929. Others of his popular works are "The Stream of Life"; "What Dare I Think?"; "Religion Without Revelation"; "Essays of a Biologist"; and "Essays in Popular Science." In these and other books he revealed to the non-scientific public the multifarious wonders of the growth of life and the half-grasped principles which seem to govern and move it; he and others like him have revealed Heredity, Environment, Sex—once mere abstract personifications of mysterious and largely ignored influences—as concrete, vital forces, to be faced, understood and controlled, at work in our own bodies and minds as well as in the bee, the buttercup and the badger.

FLIES WHOSE LIFE IS A SUMMER'S DAY

AMONG the most fragile and delicate of creatures, the May-flies are also among the shortest-lived in a state of maturity, for their adult stage is compressed into the span of a single day. If not snapped up by some prowling fish, they mostly die of exposure to the cold and damp accompanying nightfall. They are described in the following chapter, together with the caddis and alder flies

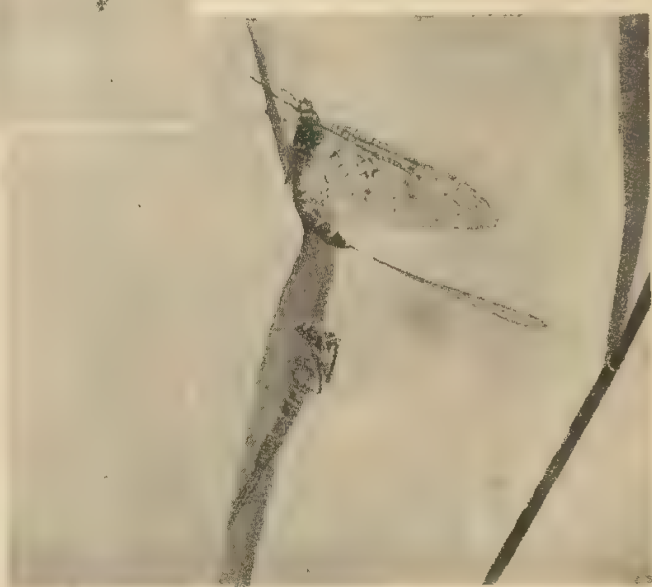
IT is about the middle of May, and the scene is set on the banks of a chalk stream in the south of England. Over the surface of the stream, in and out among the willows that line the banks, to and fro in the long grasses and the rushes that dip into the water, there dance and flutter a host of pale green, yellow, or grey flies, providing at once a feast for the fattening trout beneath the surface, and for the birds that have come from far and near to be present at this occasion, unique in the year. In angling parlance, "the May-fly are out."

For a year, perhaps two years, the dull brown larvae have crawled and swum on and over the floor of the stream, things of beauty in their own way, but very far removed, to the eye of the ordinary man, at least, from the airy, delicate insects that now flit above the water's surface. Then, one morning—it may be a morning that to the casual observer is no different from any other for a week past—the nymphs, now in what amounts to a pupal stage, rise to the surface, their skin splits, a new creature emerges, a winged fly, soft as yet and feeble, but none the less free from the case that has held it for two years and from the watery abode in which it has grown up from the egg.

Although there is no doubt that it is now fully qualified for the title of fly, this first aerial form of the insect is known to the entomologist as a "pseudimago," that is, a false adult, and is the original in Nature of one of the most killing of the angler's lures during the early summer, the "green drake." This form of the insect, which is, in fact, a stage intermediate between the pupa, as exhibited by the other insects previously described, and the true adult, lasts in various species from a few minutes to 24 hours or more. The insect makes its way to the bank, settles on reed or grass stem, and splits open once again—this time to reveal the true adult, the "spinner" or "grey drake" of the trout fisherman.

MAY-FLIES are all members of the same order, the *Ephemeroptera* (Gr. *ephemeros*, living only for a day, short-lived; *pteron*, wing), also known as the *Plecoptera* (Gr. *pleko*, I twine, twist); they are characterized by having four very fine, practically transparent wings, a slim body, which is generally held in an upward-curved position, and three long, very fine tail filaments. The fore-wings are rather long and narrow, while the rear wings are considerably smaller than the fore-wings. The life history of the May-fly, from its larval stage under the water to the aerial pseudimago and adult stages, is shown in the series of photographs in page 199.

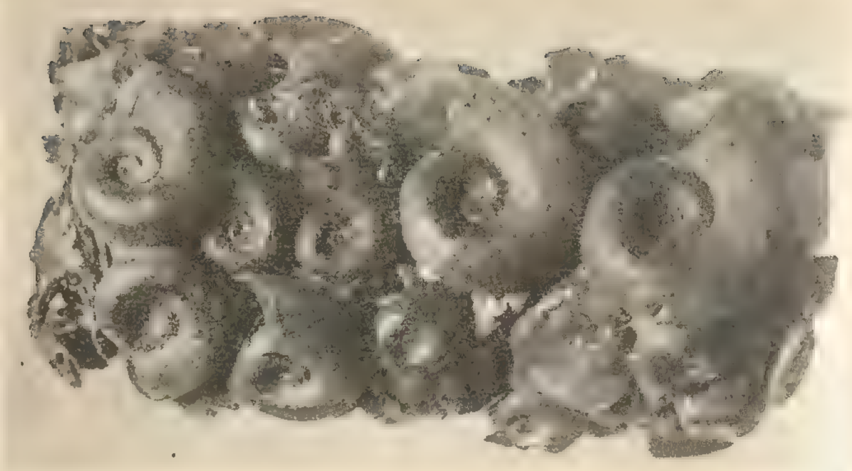
The flight to which reference has been made is the sole event of the adult fly's life, and is purely for purposes of courtship; males and females mix in one mad aerial dance, an easy prey to innumerable birds, and, as soon as they fall to the eddying surface of the stream, food for the hungry trout. The hatching of the May-fly must, indeed, be an eagerly awaited event in the life of the trout, and the excitement which it arouses must be seen to be believed. The surface of the stream boils with the rises of the fish, while the air above is alive with the rush of birds. The eggs are as a rule laid on, or just under, the surface of the water, in little masses which break up to allow the individual eggs to drop to the bottom. A few species, however, complete their life by an act of suicide. Walking down into the stream and along the floor, they lay their eggs in the security of the bottom, among the stones or weeds, and there die without ever breathing the fresh air again.



J. J. Ward

DANCERS UNTIL DUSK

The May-flies, or ephemera, are, indeed, ephemeral creatures, their lives being counted at most in hours. These photographs show (top, about life-size) an adult May-fly and (below, × 1½) one that has just emerged from its sub-imago or pseudimago stage. Note the old discarded skin on the grass blade.



J. J. Ward

Bolton

THE FLY AND ITS HOME

In their early stages, the caddis flies—an adult specimen is seen in actual size on the left—live on the bottoms of ponds and streams. There they protect themselves by building round their own bodies neat little houses, of which the right-hand picture shows a fine example (× 5).

Like the May-flies, the caddis flies make up among themselves the entire membership of their own small order in the insect world. The *Trichoptera* (Gr. *thrix*, *trichos*, hair ; *pteron*, wing), as they are called, are medium-sized, rather moth-like insects, which may be seen in

J. J. Ward

CADDIS FLY CASES

This collection of cases in which caddis fly grubs once lived gives some idea of the variety in their choice of building material. Tiny shells, pieces of stone, sand, and bits of waterweeds are all employed. The bottom row of cases are lying on their sides, to reveal the neat round holes in which the grubs live.

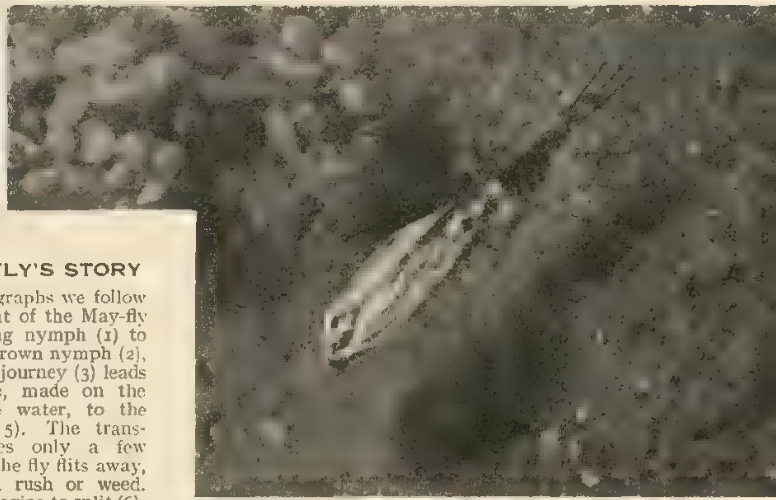
large numbers along the banks of any stream in the summer months. In their larval stage they live in fascinating little "houses" of shells, stones, etc., resting on the bottoms of streams and ponds. The principal feature of the adult fly is the wings, which are rather long, and usually brown and hairy ; the hind wings are broader than the fore-wings, and slightly shorter. The legs are longish, as also are the antennae or feelers.

In the caddis flies there is no pseudimago, for the pupa bites its way out of its own case and swims to the surface of the water, where it splits and allows the perfect insect to escape. The adults spend little of their life on the wing, but may be found sitting along the branches and stems of trees and plants growing by the water side ; on an evening walk over the water meadows or along the river bank, however, one may see them in the act of flying—pale, shadowy forms flitting along the herbage and fluttering aimlessly among the reeds. It is chiefly in the larval stage that they are attractive, and then only in the aquarium, where they can be easily observed.

ANOTHER of the flies which the rambler along the river bank may encounter is the orl fly, or alder fly, so called from its fondness for sitting on the alders that line the river-side. It is a member of the family *Sialidae*, of the great order *Neuroptera*. Of a markedly brown coloration, due to the heavy veining of its transparent, blunt wings, the alder fly does little in the mature state except sit lazily about, or flop weakly from plant to plant, and it would seem that its sole function in the adult condition is that of producing the next generation.

The grey-green eggs of the alder fly are frequently to be found laid in great masses around the stems of water-plants or on stones near the water-side. The larvae, which live under the water, have powerful jaws, are of active habit, and are provided with seven pairs of breathing organs along the underside of the body. When full-grown, the larva leaves the water and pupates in a little chamber in the bank of the stream.

All the three types of insect mentioned above have a certain commercial value, for in both the adult and the larval stages they form an important part of the food of our freshwater fishes. Indeed, it would seem that this office, and that of acting as scavengers of plant and animal life in river and pond, are the reasons for which Nature has preserved them in the world of today. At the same time they are among the oldest of all insects, for in certain deposits in which fossil insects are found specimens have been discovered that are in their essentials scarcely different from the May-flies, caddis flies and alder flies of the present day.



THE MAY-FLY'S STORY

In these photographs we follow the development of the May-fly from the young nymph (1) to the older, full-grown nymph (2), whose perilous journey (3) leads to the change, made on the surface of the water, to the sub-imago (4, 5). The transformation takes only a few seconds; then the fly flits away, to settle on a rush or weed. There its skin begins to split (6), and the adult fly gradually wriggles out (7) from the old skin which it leaves behind it (8, left, bottom). The stages seen in the first three pictures require two years, but the adult fly lives only for a day or so. Photographs 1, 2, 3 taken under water; 4, 5 on the surface. Photographs 1 and 2, $\times$ 5; 3, half life-size; 4 and 5, $\times 1\frac{1}{4}$; 6, $\times 2\frac{1}{2}$; 7 and 8, $\times$ 3.

Pathé Pictures Ltd.

FLOWERS THAT LOVE THE OAK TREE'S SHADE

SOME trees exercise a repelling influence on the flowers, grudging them the light and air and nourishment that they need. Not so the oak. Around the mighty bole, beneath its far-spreading, shaggy arms, many a delightful plant is permitted to root and grow and flower. Chief among the flora of the oak wood is the bluebell, and this, together with some of its companions, is described and pictured here and in page 213

IN one thing above all others the rambler in England is particularly fortunate, and this is that almost throughout the year there is a succession of flowers that grow and bloom in such masses as to carpet the ground and make a blaze of colour, refreshing alike to the tired visitor from the towns and the expectant countryman. In the spring, especially, our flowers appear in masses. Earliest are the daffodils and the primroses in the fields and woods, and then, following them in later spring, come the bluebells and the cowslips.

The bluebells, or wild hyacinths, make probably the most brilliant show of any of our native flowers. Primroses may adorn the banks in luscious bunches, or carpet the ground when the hazel scrub has been cleared in the oak wood, and daffodils make the meadows golden in spring; but neither primroses nor daffodils spread so wide and thick a cloak as do the bluebells when they are at the height of their blooming. Even before the flowers are out, the spikes of straight, bright-green leaves show like an army of spears, many of which, as they grow upwards, pierce the dead oak leaves and lift them several inches above the ground, impaled on their green stakes. Where the plants are growing somewhat apart the leaves form a true rosette, spreading close to the surface of the soil, but the plant is so prolific that there is often no room for this growth in even a small colony.

BELLE OF THE OAK WOOD

One of the loveliest and most popular of all our spring flowers is the bluebell—or wild hyacinth, as it is sometimes called—found in large numbers in most parts of the country and particularly in the oak woods of southern England.

H. Bastin

Such massed formation as colonies of bluebells assume is due to the fact that the plant may reproduce itself by means of bulbs, which are of the same type as those of the daffodil. These whitish bulbs may often be seen in summer and autumn, dug up by rabbits or other animals burrowing in the woods for provender. The leaves are simple, radical and entire; they grow later in the year to twelve inches or more in length. Each plant bears but one flower stalk, which arises from the midst of the leaf-rosette, growing straight upwards to a height of eighteen inches or more. This flower stalk is very juicy, and is white at its base, though the part that is normally visible is green. The inflorescence is of the type known as a raceme, there being from five to twenty flowers on a single stalk.

Analysing the Bluebell's Flower

IT is often said that there is no pure blue colour in flowers, and this is certainly true of the bluebell, the blossoms of which always show a certain tinge of purple; occasionally examples are found in which the flowers are white, but even then there is a faint tinge of purplish-pink. Each flower consists of a six-lobed perianth, the petals and sepals being indistinguishable; the flower is about half an inch across at the mouth, and rather more in length, and is of a very characteristic bell shape. In the bud the flowers stand upright, but as they open the short stalks bend over, and when fully out they hang downwards. At the base of each flower stalk there are two bracts. When the flowers are wide open, too, the lobes of the perianth curl back to display the six yellow anthers, borne on filaments which are fused to the perianth. There is a single, very small stigma borne on a fine, thread-like style. The fruit is of the type known as a capsule (Lat. *capsula*, little box), a dry case which opens, in the present instance, by splitting from the top downwards, revealing three cells, each of which contains a number of shining black seeds. Long after the flowering

is over these capsules, borne on the elongated flower stalks, are a conspicuous feature of the oak wood.

The bluebell, together with the primrose and, to a lesser extent, the wood violet, is a member of a group of flowers that are especially found in the oak woods. The oak wood is one of the most marked examples of what is termed an "association," that is, a number of flowers, insects, birds, and beasts, all of which have more or less the same habitat and whose lives are to a large extent interdependent.

Nature's Sequence in the Oak Wood

ONE of the most noticeable features of the oak wood in early spring, long before the bluebells are in bloom, is the undergrowth of hazel bushes, conspicuous now on account of the long, drooping male catkins, pale yellow in colour, that droop from every branch. They are the first of the flowers of this association, and are succeeded by the primroses and then by the bluebells. Among the bluebells we may find a number of delicate white flowers growing on a plant whose leaves are extremely beautiful and decorative. These are windflowers, or, as they are better known, wood anemones.

M. H. Crawford

FLORAL WEATHER-VANE

The wood anemone, known also as the windflower, is extremely sensitive to air currents, and the weather must have been particularly fine when this picture was taken, for the little flower is turning its face wide open to the sky.

The name windflower is in part a translation of the name, anemone, since this is itself derived from the Greek word *anemos*, meaning wind. It was apparently given to the flower in former times on account of its habit of always turning its back to the wind, in the manner of a weather-vane, since the slightest breeze will cause these delicate blossoms to swing round on their long, slender stems. Besides its attractive appearance the anemone has also a very pleasant, if rather faint, scent.

At first sight it would appear that the anemone has six white petals, the backs of which are flushed with a rosy-pink tinge, but in actual fact these are the sepals, enlarged in this case to become the most conspicuous part of the flower. The petals are absent. The wood anemone, a near relative of the anemones which are popular as garden flowers, is also closely related to the buttercups. Each flower grows singly on a longish stem, and there appear to be three leaves in a whorl some distance below the flower. Actually these are not leaves, but bracts which have become leaf-like; they cover the flower bud during the cold days of the early year, forming what is known to botanists as an involucre (Lat., *involucrum*, a wrapper) because it encloses the bud. The true leaves, which, like the bracts, are divided into three lobes, each lobe being again cut up, appear some distance from the flowers, springing direct from the ground. The centre of the flower is occupied by a large number of bright yellow stamens.

A. H. Dennis

WINDFLOWER WALK

This ride through a typical coppice of oak and hazel is literally carpeted with dainty anemones or windflowers, making a picture of floral loveliness delightful to the eye accustomed for long months to the sombre hues of winter.

Sensitive Wood Sorrel

ANEMONES often grow so thickly as to become as noticeable a feature of the wood as the bluebells, but we have to search carefully to find many of the other typical flowers of the oak wood. One of these is the wood sorrel, a plant related to the geraniums of our gardens, and one that is quite unmistakable. The leaves are of

H. Bastin

AWAKE AND ASLEEP

The wood sorrel, pictured in these two photographs, is one of our most sensitive plants. Above, it is shown awake, when the sun is shining; flowers and leaves are wide open. If, however, a cloud passes over the sun or a cool breeze disturbs the plant, then its flowers droop and its leaves close up (right photo).

the traditional clover-leaf pattern, consisting of three lobes, each of an inverted heart shape, and each neatly folded down the middle. The bell-shaped flowers, which are each on a separate stalk, hang downwards, and are of a pure white colour with very delicate purple veins. There are five sepals, petals and stigmas, and ten stamens. This plant is remarkable in that both its flowers and its 'eaves are extraordinarily sensitive to light and weather, and even the leaves close if the day is dark or very cold. Another interesting point is that the plant bears large numbers of flowers of the "blind" type, described in Chapter 4 of this series (page 130). The leaves of the plant are sometimes used as a flavouring for salads; they have a bitter but refreshing taste.

In the wood sorrel we find a method of securing seed distribution that is different from that in most flowers. The seeds are contained in a little capsule, which, when touched, splits open and discharges the seeds to a distance of several yards.

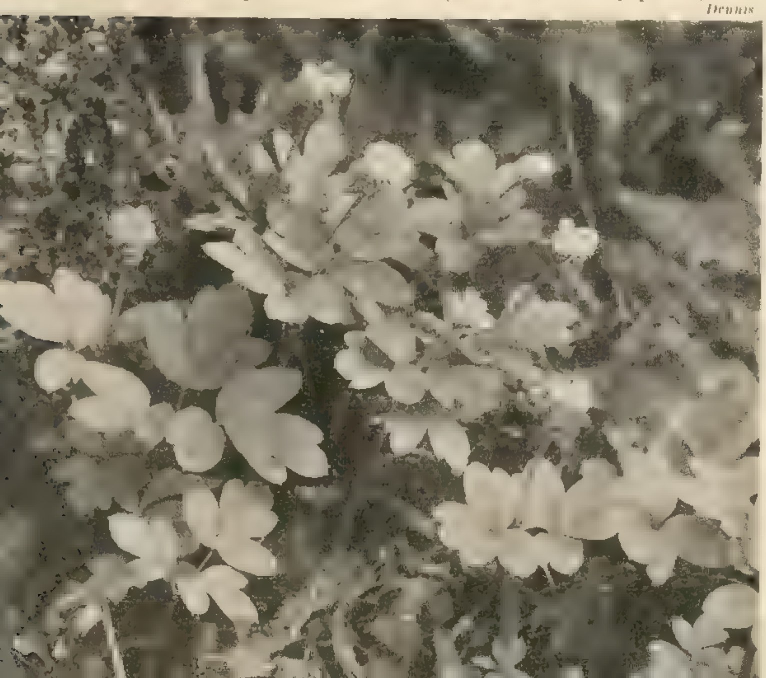
Growing in the same situations as the wood sorrel is a curious little plant which is likely to escape the notice of an unobservant person. This, the moschatel, has a simple stem, at the top of which are five little flowers, which are always arranged in the same way. Four of them are at right angles to each other, facing outwards and having all their parts in fives; the fifth faces the open sky and has its parts in fours. This manner of inflorescence has earned for the plant the popular name of "the town-hall clock." The leaves of the moschatel spring direct from the rootstock and are cut up into a number of fairly large lobes.

Elsewhere in the oak wood we may find a tall, leafy plant, with an upright stem which bears many leaves

MODESTY PERSONIFIED

Many of our woodland plants are unassuming, but few are so modest as the moschatel. Not only is it tiny and unpretentious in habit, but its flowers are of a colour—pale yellow-green—that easily escapes notice. Its leaves, however, are very pleasing.

Dennis



Dennis

'TOWN-HALL CLOCK'

This is the name given by country children to the moschatel, and a glance at these two photographs of the flowers, enlarged about four times, makes clear the reason. The inflorescence has four flowers facing one in each direction, while above them is a single flower (whose parts, incidentally, are in fours instead of fives) turned to the sky above.

bright yellow-green in colour and sometimes slightly tinged with red. This is the wood spurge. The flowers are of a very curious form, quite unlike any others, and yellowish-green in colour. At its top each stem breaks into a five-branched umbel, at the base of which there is a whorl of leaves, like those on the stem, and these are of a long, ovate shape, downy beneath. At the top of each ray of the umbel there are rounded, perfoliate bracts. The flowers are devoid of sepals and petals, but are borne in groups. Above each set of bracts there is an involucre which contains a ring of tiny, single-stamened male flowers, and a solitary female flower. The most

LEAFY WRAPPERS

The curious saucer-shaped objects that would seem to be the flowers of the wood spurge are termed involucres, or wrappers. Inside them, in addition to a quartet of crescent-shaped nectar-glands, easily seen in the above photograph, are contained the hardly noticeable male and female flowers.

FLAUNTED HOMELINESS

Every plant must seek some way of attracting the attention of insects. The wood spurge strives to entice its winged friends from its numerous rivals by spreading its green and insignificant flowers over as wide an area as possible, as seen in the photograph below, taken from vertically above the stem.

L. Boulin

notable part of this arrangement is to be found in the nectar-glands, of which there are several to each involucre, of a crescent shape and bright yellow in colour.

In autumn the whole spurge plant becomes reddish in colour, so that throughout the year it is one of the most conspicuous features of the wood. The plant contains a thick, milky juice, which in species found in other parts of the world is deadly poison. The dog's mercury, described in Chapter 5, page 163, and the box tree are other members of the same family as the spurges.

HOW TO PRESS FLOWERS. 4

This "practical note" concludes the series dealing with the technique of pressing flowers; the previous notes will be found in pages 46, 93, and 176

In mounting, place the pressed flower upon the mount, and arrange it in as natural a position as possible. Then mark with a pencil the points where lie the stalk and principal flowers and leaves. The plant is then laid face downward on to newspaper and covered carefully with the paste. Now lay it again on the mount, the guiding marks showing how it should be arranged. Cover it with blotting-paper, smooth it down, then cover with newspaper and a piece of cardboard, and put two or three flat-irons on the top. Now remove the pasted piece of newspaper and continue with the next plant. Knobby plants should be separated from the others with pieces of cardboard.

In about 3 hours' time look at the plants again, and touch with paste any twig or petal that has not stuck. Thick stalks and seed pods will need gum or thin glue to fasten them securely. A thin strip of adhesive tape will keep a bent piece of stalk in place. When the plant is thoroughly stuck down and the paste quite dry, it can be put away into a drawer of the herbarium cabinet, or into a box kept for the purpose. The plants should be classified according to their order and genera.

If there are many interesting varieties of the plant, it is as well to attach fairly full notes at the side of the specimen. The soil in which it was growing, the aspect of the situation and the nature of the climate, are all worthy of note, for many sub-species of plants are confined to small districts and are controlled entirely by such factors as soil and climate. It should be possible, where notes are kept, to run down any variety to its exact sub-species. In time, one should manage to collect a complete series of any variable plant, showing the gradation from one extreme, through the typical form, to the other extreme.

A label of standard type, showing at a glance all the most important particulars with regard to each specimen, should be pasted to the mounting sheet in every case, and the additional particulars may be written alongside. Furthermore, a book should be kept in which every specimen is entered, and, if necessary, any further matter can be added therein.

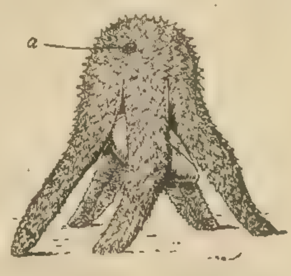
The label itself should show the following particulars: English and Latin names of the specimen, or of the variety to which it is assigned; locality in which it was found; natural order to which it belongs; any remarks of primary importance (e.g., if it is new to that locality, if it is exceptionally early or late in flowering); the date on which it was obtained; the number and other references in the collection; and the collector's signature or mark. This last point may seem insignificant, but it is of importance, since in years to come the authenticity of the record may depend finally on the collector's reputation, and a specimen from the collection of a man of established name is of far more value to all concerned than one that is unsigned.

STARFISH SCAVENGERS OF THE SHALLOW SEAS

EVERY visitor to the seaside confidently expects to find in the course of his ramble along the shore a starfish or two, abandoned on the sand by the ebbing tide or left in the comparative security of some rock-bound pool. Starfish are of many kinds, but among the most generally met with are those mentioned and pictured in the pages that follow

PERHAPS the commonest and undoubtedly the most interesting of the treasures to be discovered on the seashore when the tide has retreated are the starfish, so called because of the five rays which protrude from the central disk-like body and so give the appearance of a star. In scientific language these animals are classed as Echinoderms or *Echinodermata* (Gr. *echinos*, hedgehog; *derma*, skin), from the spiny nature of the skin covering the whole of the flabby organism.

It is hard to believe when one first sees a starfish cast up on the shore by the waves that it is in reality an extremely energetic, one might say athletic, animal. It is, of course, at a disadvantage when out of the water, but its appearance, unlike that of a fish on dry land, gives no remote suggestion that it may be active when in its own element. This is, however, the case; and the starfish is among the most detested foes of the fishermen. It is even able to force oysters from their shells and eat them, a task requiring skill as well as energy, and whole oyster beds are often destroyed by the ravages o the starfish, which in battalions thousands strong can destroy a really large oyster bed in a few days.



STARFISH FEEDING
In this sketch *a* shows the "madreporite" through which water enters the starfish's system.

In opening the shells of oysters and mussels the starfish makes use of the tube-feet situated on the underside of the arms of the star, by means of which it is also able to move about the bed of the ocean with considerable speed. Settling on top of the luckless shellfish, the starfish grasps its victim with its five arms, which bend inwards over the two sides of the shell. The tube-feet are then extended from the underside of the arms, and by strong powers of suction they grasp the shells firmly and exert a steady pull, which can be kept up for hours if necessary. The oyster can, of course, resist for a considerable time; but it is of no avail, for the muscles of the starfish seem to be tireless. Moreover, it is believed by some naturalists that the starfish, putting its mouth to the edge of the two shells, injects some poison into the oyster which eventually paralyses its muscles and renders them incapable of keeping the shells together. When the shells fall apart the starfish envelops their contents with its five arms and sucks the body of the oyster whole into its stomach, where the process of digestion proceeds until all the edible parts of the shellfish have been absorbed.

TRACKS IN THE SAND
By means of its tiny tube-feet situated on the underside of the rays, the starfish is capable of propelling itself across the damp sand at a rate of about six inches a minute. Careful examination of the photograph below will reveal the creature's footprints—groups of little dots situated on either side of the track.
F. Martin Duncan

F. Martin Duncan

"CARTWHEEL" PROGRESS

For crawling on wet sand, the starfish uses its tube-feet, but under water it raises itself on the tips of its rays and then turns over and over in "cartwheel" fashion. Very often this procedure results in a fall if the water be disturbed.

One of the most remarkable characteristics of the starfish is the manner in which it can replace lost limbs; under the most trying circumstances it will hold on to life even if it may mean the casting of all its members. The fisherman who happens to pull up a starfish on his line should not, in his annoyance at having lost his bait, hack the animal in pieces and throw it back into the water, for in this way he will be defeating his object. It is more than probable that every piece of the original starfish he throws back will grow into a full-sized member of the family, all equally ready to devour his bait at a later date!

Apart from the tube-feet with which the starfish is able to move about and to capture its prey, it has also a very large number of another kind of minute appendages, the function of which seems to be to keep the body clean and free from the tiny objects which tend to cling to it. These *pedicellariae* (from Lat. *pediculus* [*pedicellus*], diminutive of *pes*, foot) take the form of miniature pincers, consisting of two blades attached to a basal stalk. If these are touched by any small object in the water, the blades at once open wide apart and then snap quickly together, retaining a firm grip on the object seized for a considerable length of time. These pincer-like organs are characteristic of the group of organisms

Oysters are not the only food upon which starfish subsist. They have indiscriminate appetites and, in fact, are looked upon as among the most efficient of the scavengers of the sea. If a starfish is examined and turned over on its back, its mouth is easily discovered. It appears as a small opening in the centre of the disk-like body, and if the tip of the little finger is put into the hole one can feel the suction at once applied to it. The mouth is extremely elastic and can stretch to almost any size. The starfish, however, is sometimes mistaken regarding the limit of its elasticity, and it is not an uncommon sight to find one cast up on the beach with a partly-devoured shellfish (complete with shell), too large to be swallowed all at once, stuck in its mouth.

The bag-like stomach fills the whole of the centre of the starfish's body and projects a little way into each of the rays. From the mouth little grooves run down each of these rays; in a living specimen, these are seen to be lined with a very large number of tiny tubes which twist and turn, elongate, contract, and bend in all directions, as if perpetually seeking something to grasp in order that the starfish may turn itself right side up. They are the starfish's feet; with them it can move rapidly over the rocks and sand at the bottom of the sea, but they are worse than useless when, through bad luck and perhaps an over-greedy search for food too far up on the shore, the starfish finds itself left high and dry by the ebbing tide.

LOADED WITH EGGS

This picture shows the underside of the starfish *Luidia*, dissected to reveal the thousands of eggs hanging within the cavities inside the rays. Although so many eggs are produced, the naturalist rarely succeeds in discovering this species in its larval form.

F. Martin Duncan

F. Martin Duncan

STARFISH ALL

The numerous forms of the starfish as represented by the different species are well demonstrated in the above photograph. Top left is the sun star, whose arms may exceed thirty; next it is the bird's foot star; bottom row, left to right: the but-thorn star, which has no suckers, cushion star, cribella, and gibbous cushion star—the smallest British species.

to which the starfish belongs. In some of its nearer relations they are often very highly developed, forming complex and sometimes poisonous weapons used for the capture of prey as well as for defensive purposes.

There are many types of starfish, but quite a number are to be found only at a depth of perhaps five or six fathoms. The sand starfish and the brittle starfish are creatures which possess all the fundamental characteristics of the more common types, although they have a widely distinctive appearance. In both cases the rays are very much longer, and the centre part of each arm is formed of a bony axis, composed of successive joints, which occupies the whole of the internal cavity, there being in this case no longitudinal groove filled with tube-feet. The spines of the brittle starfish stand out on the rays almost at right angles, having the appearance of fern fronds; and these arms, covered with short spines, twist and turn as the starfish feels its way about the ocean bed.

The Shetland argos and the closely-allied Gorgon's head, or Medusa, as it is alternatively called, in which the slender arms are repeatedly forked so that a crown of interlacing branches is formed, are two more of the most interesting though rarer species of starfish.

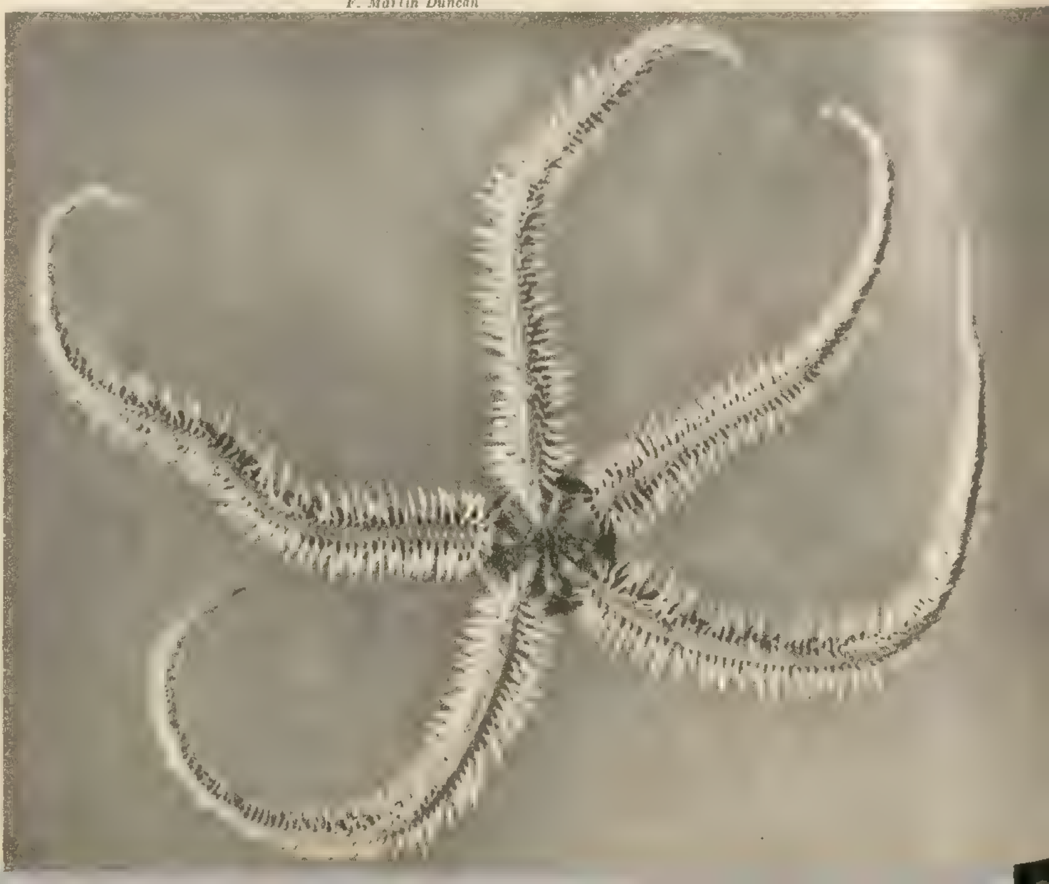
It is not generally known that the sea-urchins, which look not unlike some strange hard-shelled fruit of the sea, are a third division of the Echinodermata. The outer skeleton of these orange-shaped organisms, except for a space round the mouth, is formed of the same material which makes up the spines and plates covering the arms of a starfish. The sea-urchin may, in fact, be looked upon as a starfish in which all the five rays have been brought together at the tips, thus acquiring the semblance of a sphere. In the sea-urchins the pincer-like organs are very highly developed. The mouth of the animal is situated on the under surface of its body and is provided with five long, sharp-pointed teeth with which it masticates its food.

The different species of sea-urchins found along our coasts vary very considerably in both shape and size. The common variety (*Echinus esculentus*) grows to the size of a large Jaffa orange, and, although it does not eat oysters, it consumes otherwise much the same food as the starfish. On broad, sandy shores we very often come across the

BRITTLE STAR

This species of starfish is distinguished by its long, tapering and extremely brittle rays, which are liable to break off at the slightest touch. The greater part of each ray consists of a bony axis composed of successive joints, which fills up practically all the internal cavity.

F. Martin Duncan



remains of a sea-urchin, the hard outer test or shell lasting for many years after the death of the animal of which it formed a part. The heart-urchin, a curious species to be found along our coasts, spends its life hidden under the sand at a depth of about ten inches. It maintains communication with the outside world by means of a narrow, cylindrical hole by which the animal keeps in perpetual contact with the oxygenated sea-water above. The cake-urchin is also sometimes found along our coasts, though it is by no means quite so common. It lives half buried in the sand when the tide is out, but comes to the surface as soon as the waves cover the beach once again. These animals have gained their name from their flattened, oval shape, which is suggestive of a small cake.

In the sea-urchins the curious pincer-like organs found also on the starfish are most highly developed, four specialized kinds being found on the body of the common sea-urchin. Each of these separate types has its special function, either as a cleansing organ or as a weapon used in the capture of prey.

Although not so commonly found on the seashore as the starfish or the sea-urchin, the sea-cucumber, despite its soft, flabby and by no means brittle construction, is certainly a member of the same family as these other two forms of life. Among the most interesting of fossil forms are the fossilized echinoderms, which are found chiefly in chalk and are frequently mistaken for " thunder-bolts."

UGLY BUT EDIBLE

Of the same family (*Echinodermata*) as the starfish, the sea-urchin is almost spherical in form, suggesting that the tips of the star have been joined together. This photograph of an edible species was taken under water, and gives a good impression of the animal in its living state.

F. Martin Duncan

THE GORGON'S HEAD

This starfish bears little resemblance to the other species pictured in this chapter. The long, slender arms of the central, disk-like body are forked so as to form a crown of interlacing branches suggestive of the " curls of hissing snakes " that the Gorgons of the classical myth wore in place of hair. Another name for this species is Medusa, named after one of the Gorgon trio.

HOW TO COLLECT STARFISH

Few ramblers on the seashore ever think of making a collection of the dried tests or shells of *Echinodermata*, yet this forms a fascinating and instructive pastime.

As stated in the chapter above, there are numerous different species of starfish to be found along the coasts of Britain, as well as a large number of different species of sea-urchins and sea-cucumbers, all of which are found more commonly dead than alive. Sometimes the action of the sea-water and the heat of the sun may dry these specimens while they lie on the beach, so that the amateur naturalist has but to pick them up and take them home for his collection. More often, however, they will be found to have died only a few hours before, and it will then prove necessary to remove the flesh from the inside before artificial drying can be carried out. This operation can best be accomplished by placing the specimens in a vessel containing very dilute caustic soda, and gently raising the temperature of the solution until the flesh has been fully dissolved. The specimens should then be dried either in the sun or in a well-ventilated oven with the door open. When ready for display the specimens can be either gummed on to white cardboard or arranged in a cabinet set aside for the purpose.

Specimens to Look For

Of the various species of starfish which the amateur naturalist should endeavour to include in his collection, the common star is undoubtedly the most important, but specimens of the sun starfish, the brittle star, the cushion star and others pictured in the above chapter should also have their place on the shelves of his cabinet. Perfect specimens of the linghorn starfish (*Luidia ciliaris*) should be particularly coveted, for this species is extremely difficult to obtain in a well-preserved condition, owing to the brittle nature of the rays, which break under the slightest strain. For this reason, only small portions are likely to be picked up on the shore. Complete specimens may be obtained by trawling with a drag-net out at sea, but even under these conditions it is hard to remove the linghorn from the water without breaking off one or other of the seven long, flat rays with which it is provided when in a complete state.

THREE LEAF WARBLERS OF THE WOODLAND

THREE birds very similar in appearance and alike in the persistency with which they maintain their song are the subject of this chapter—the chiffchaff, the willow warbler, or willow wren as it is sometimes styled, and the wood warbler. All three are valuable allies of the gardener in his unending warfare against insect pests

WALKING in the woods in early spring, we may often hear a clear, distinctive little song of two notes, repeated again and again so insistently that when it ceases its absence is at once noted. To find the bird that is responsible for this song may take many minutes of careful waiting and searching and watching, for the insistent songster is the chiffchaff, one of our smallest and most unassuming birds. From March until often well into October the woods ring with those two clear notes, from which the bird has got its name.

One of the commonest of the warblers, members of the great group of passerine birds, the chiffchaff is a bird that is often overlooked, not only because of its small size and sober colour and habits, but also on account of the nature of its song. We may live in the country for years, in a district where there are plenty of these birds, and yet never notice their existence, so much is the song a part of the atmosphere of the countryside. Then, one day, a friend perhaps remarks on it, or a visitor asks what bird it is, and for the first time we notice it. Once heard, the chiffchaff can never be forgotten. One of the earliest of our summer visitors to arrive in the spring, it starts to sing as soon as it reaches this country, and keeps up an almost continuous song from then until its departure in October. During the summer months, however, the stronger tones of other songsters drown its clear notes, but as the general flow of song dies down in late June or July, we hear it once again. To many people the chiffchaff's note may by its very insistence become almost intolerable, but under the great roof of a leafy beech wood or among the thickets in the oak wood there is a companionable quality in the song of this little bird that is found nowhere else.

WHOSE SHALL IT BE?

A fine, fat fly is the reward of patience on the part of one or the other of these plump young chiffchaffs, but which of them will receive the tasty morsel is still a matter for doubt. The delicate form and dainty bearing of the parent, shown here about life size, is typical of all the warbler tribe, to which it belongs.

J. Markham

In appearance the chiffchaff may best be described as a dainty, slim, yellowish-green bird, with pale-greenish underparts and a light stripe over the eye. The length from beak to the tip of the tail is $4\frac{1}{2}$ inches, and when the wings are fully spread the span is not more than six inches. The nest of the chiffchaff is in its own way a real work of art. Grasses and leaves are cunningly interwoven to form a domed structure with a largish hole in one side. The lining is of small, fine roots, grasses, hairs and feathers. This nest is usually placed near the ground in thick herbage or bushes, but it may also be many feet up in the mass of leaves and twigs that collects in the branches of big trees. The eggs, which are from five to seven in number, and are white with a few small spots of brownish-purple (*see* colour plate facing page 165), are laid in late April or May, and there are sometimes two broods.

Fine Singing of the Willow Warbler

NATURALISTS who learn to recognize the chiffchaff by its song and by sight may sometimes be surprised to hear a very different note from a bird which appears to answer exactly to the above description. This is the willow warbler, also known as the willow wren, although it is not even a near relative of the true wren. In appearance it is, to all but the expert, indistinguishable from the chiffchaff, for the sole outstanding difference is that its beak and legs are brown, whereas the chiffchaff's are black. For sheer purity and sweetness the song of the willow warbler is almost unsurpassed, and a really fine willow warbler in full song may be listened to for hours at a time with pleasure. The bird starts to sing a week or so later than the chiffchaff, but, sharing with that bird the quality of persistence in its singing, it soon becomes heard wherever there are the hedgerows and woods that

E. L. Turner

CHIFFCHAFF VILLA

Snugly fixed between two posts in a fence, this chiffchaff's nest is an illustration of the bird's occasional preference for a well-hidden site some distance above the ground. The mother bird, probably just returned from a foraging expedition, is about to settle on the young, who are just visible inside the nest. Another chiffchaff nest is illustrated in page 143.

it frequents. Starting with a few strong, full notes, the song goes up and up, then suddenly breaks and falls, dying away in a long, delicious, tender warble. No other bird-song has such an air of pathetic sweetness, and yet at the same time, by virtue of the qualities just mentioned, the willow warbler can drown all other songsters, its notes standing out distinct from the general singing of the avian choir.

Unlike the chiffchaff, the willow warbler does not sing throughout the season, for during the summer moult it is silent; but it is often heard in autumn, when the song is rather weaker, though no less sweet.

The nest of the willow warbler is more or less of the same materials as that of the chiffchaff, although, from the bird's liking for more open country, it often uses bracken. The site also is normally on the ground, frequently among the bracken fronds or in the litter that accumulates at the bases of thick shrubs and hedgerows. The eggs, similar in appearance and number to those of the chiffchaff, are a trifle larger.

Friends of the Gardener

Both these birds may be counted among the gardener's friends, for they spend many hours in the orchard and the vegetable garden, where they pick caterpillars and grubs, flitting daintily among the plants. Sometimes, too, in summer, they will hawk after flies and other flying insects, and, although they are often seen in the fruit-cage running and hopping among the raspberry and currant branches, they are hardly ever guilty of eating bush-fruit, being attracted thither not by the fruit but by the insects. So small are they that the meshes of the netting generally used by the market gardener do not impede their entrance and exit, and, indeed, they do so much good that it would be folly to try to stop them.

DOWN AMONG THE LEAVES

The wood warbler, illustrated in the photograph below, almost invariably builds its nest on the ground, among the mass of leaves or decayed herbage that forms the floor of the wood. A larger bird than either the willow warbler or the chiffchaff, it is also distinguished from them by its more slender build and yellower colouring, especially visible in the eye-stripe.

Arthur Brook

R. Gaze

HUNGRY CHORUS

Impatient for their next meal of grubs or insects, these little willow warblers have evidently caught sight of one of their parents, and are clamouring expectantly for food. One of them, indeed, unable to control his impatience, has been so bold as to clamber on to the edge of the nest.

of the song, and then a long, quivering cascade of silvery sound—an arresting and never-to-be-forgotten piece of natural music. This song is poured forth from a twig or low branch, although the introductory phrases may be made on the wing, and the bird sings in between the little flights it makes in pursuit of insects.

In common with its two cousins, the wood warbler picks grubs and beetles off the undersides of leaves, a habit which has earned them the name of leaf warblers. The nest conforms to the general type already described, except that it is always placed on the ground, unless it is actually in a hole or old burrow; feathers are never used for the lining. Five or six eggs, slightly larger and more spotted than those of the willow warbler, are laid in the latter half of May.

The three little birds described in this chapter are the first members of the great family of the *Sylviidae*, or warblers, that we have so far encountered. They show admirably well the characteristic features of this family, which is one of those included in the passerine group. Soberly clad, they are all small birds, of neat appearance and active habit, mostly insect-eaters. The three leaf warblers described above, are amongst the most attractive members of the whole group, their antics when searching the tree-tops for food being often as entertaining as those of the little tits. The further feature of a fine singing voice, common to almost all the warblers, is well exemplified in the willow and wood warblers, although the song of the chiffchaff falls perhaps a little below the standard one is accustomed to expect from a bird of this group.

There seems to be no particular reason why the willow warbler should have been so named, for it has no apparent connexion with willows; but its near cousin, the wood warbler, is very appropriately named. Even more than the chiffchaff, this is a bird of the woodlands, loving especially those districts where oak and beech abound. To the eye, it is a arger, slimmer, and very much yellower bird than either of its cousins, and it arrives in this country considerably later, being seldom seen before the middle of April. It also leaves us earlier, going in most years in August, though it sometimes stays well into September.

The song of the wood warbler is one of the most beautiful of all the songs of birds, well meriting the description given it by W. H. Hudson—"a long, passionate trill—the woodland sound which is like no other." One or two single notes, rough and uneven compared with the rest

In one feature, however, these three do differ from the other members of the family; their nests are of very different form to those found among the other species. Instead of the solid, cosy, domed structures illustrated in this chapter, the other warblers are content often with nests so flimsy that the eggs can be seen through the bottom. Although often deep-sided, they are frequently quite shallow and open, the fact that they are hidden far in the depths of a bush being relied upon to protect them from their foes.

HINTS ON BIRD-WATCHING. 4

Once the young birds have hatched in the nest, watching activities may be divided between watching at the nest, and watching at places we know that the birds are likely to visit in their search for food. It is often found that one particular pair of birds has a weakness for one especial article of food. Many of the small warblers will be found to confine their attention to one hedgerow, or one tree, and we may glean much information by examining such places in order to see what insect is forming the staple article of food. When, as is often the case, the oak trees are infested with the little, green, oak tortrix moth, the chiffchaffs and warblers of the neighbourhood will be found in numbers, picking the caterpillars off the leaves. It is from such observations as these that we can appreciate how every branch of Natural History is only a small part of what is scientifically called ecology.

Measuring Bird-flights

Many interesting particulars have been collected with regard to the distances travelled by a pair of birds every day while they are feeding their young, and some of the facts which experts are able to lay before us in this connexion are truly astounding. It has been calculated, for instance, that the collecting of feathers for the nest built by a single pair of long-tailed tits may mean journeys to the extent of 600 miles. Perhaps an even more impressive piece of research is that which shows that for every hundred yards that the food-supply is distant from the nest, a pair of blue tits fly 60 miles a day.

Such results as these, it is obvious, can be obtained only by continuous watching and the most careful and accurate system of taking notes, and it is only such accurate work that can be of lasting value. At the same time, it should not be forgotten that every note, provided that it is made by someone who sees really what *is* happening, not what he expects to happen, is useful in helping to solve the mysteries of Nature.

CHIFFCHAFF REVERIE

This perky little fellow, sitting in the entrance of its cunningly-devised and exceedingly cosy home, is one of the chiffchaff tribe whose persistent song is so noticeable throughout the months from early spring till autumn has nearly gone

CHERRY-BLOSSOM TIME

Many a poet in verse and prose has sung the praises of the wild cherry when wearing its vernal dress of delicate blossom, pearly-white in the sunshine. George Meredith was so impressed by the virginal purity of its appearance that he styled it the "Vestal of the Woods".

BLUEBELL GLADE

Individually beautiful though it be, the full glory of the bluebell is only displayed in some such situation as is seen in this camera-study of an oak-wood clearing. Then the masses of lovely colour make one of the finest pictures painted by Nature's brush

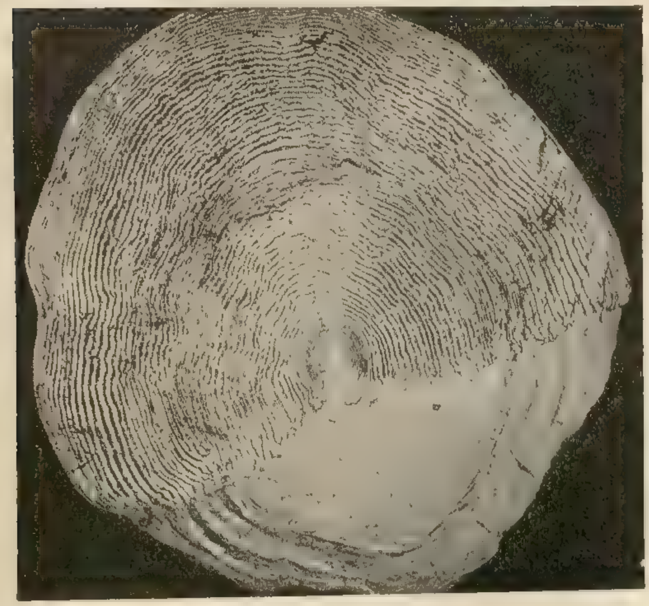
LEAPING THE FALL

Impelled by primitive instinct, the salmon at maturity turns its back on the sea, enters a river and presses steadily upstream until a suitable spawning-bed presents itself. Raging torrent, waterfall, whirling rapids—these may deter but seldom arrest the fish's progress

WITH THE SALMON IN RIVER AND SEA

Some may argue that the salmon, described below, should be given a place in the series devoted to the Fishes of Our Seas, but though it migrates to the sea on the approach of maturity, the fact that what is, perhaps, the most interesting stage in its life history is spent in river waters justifies its inclusion here among the freshwater fish

Although, strictly speaking, the salmon is not a freshwater fish, it is at least associated in our minds with the fishing of inland lakes, with the sounds of a slowly drifting river, or with the roar of a waterfall, where every now and then the silver flash of a leaping fish may be seen. Much scientific research has been carried out in order to determine whether the salmon is a true inhabitant of the sea or whether it is a natural dweller in the river and the lake. The generally accepted theory today is that salmon, together with the majority of the other teleosts originating in the ocean, found that they were unable to protect their eggs during the spawning season against the ravages of other piscine



RINGS OF AGE

From the appearance of a salmon's scale may be deduced its age. Each fine ring represents a period of growth; a jagged ring indicates a period immediately after spawning, when the fish is in poor condition and the scales hang loosely on its body. In the above photograph one jagged ring is apparent about half-way from the centre, and a second close to the outer edge. As a salmon spawns after its second year, the fish was four years old.

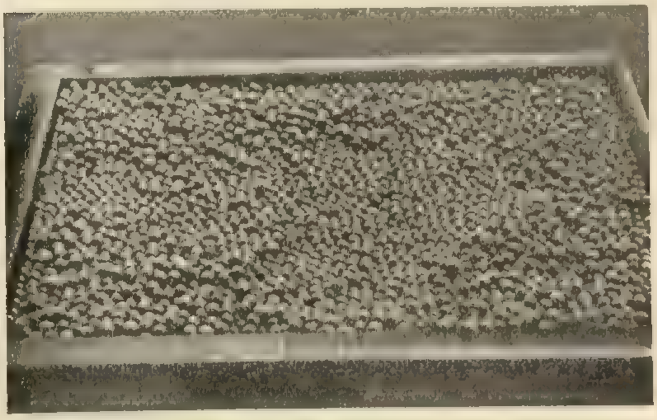
species and therefore sought for themselves a safer breeding ground in the river estuaries. As time went on even the muddy bottom of estuarine waters became unsafe, and eventually the salmon were forced farther and farther upstream, until, finally, it became their annual practice to spawn and fertilize their eggs on the gravelly bottom of the headwaters of a river.

Every year in the autumn our rivers are invaded by salmon surging in from the sea, sometimes in such large numbers that the waters are blocked with their bodies, and it is this annual immigration which has given rise to the popular idea that salmon are naturally freshwater fish. Actually, however, their feeding grounds are confined almost entirely to the ocean, and during their journey upstream and afterwards it is a debatable point whether they eat anything beyond an occasional fly found drifting on the water. It is owing to this seasonal change in feeding that one can tell the age of a salmon from the marking on the scales. During the summer the growth of the scales is faster than in winter, and the concentric lines of growth are more widely spaced. At the end of the spawning season, owing to the poor condition of the fish the edges of the scales become roughened and growth gradually ceases, but with the arrival of spring growth proceeds once again. By counting the roughened scales we may arrive at an approximation to the fish's age, remembering that spawning begins in the second year.

Throughout the breeding season, while the fish are eating so little, their stomachs are contracted and practically no gastric juices are excreted by their glands. All the materials necessary for the production of sperm and eggs are drawn from the fatty tissues which make the salmon's flesh so nutritious. This is why after the breeding season it is useless to catch the fish, which are thin and contain little nourishment.

Cooperation on the Breeding Ground

When the female salmon starts on her journey to the spawning ground she is at first without a mate, but after a time a male fish selects her from the thousands travelling upstream and the pair go on together. Undeterred by the innumerable obstacles, they press on, fighting the adverse current and overleaping rapids and waterfalls. When they reach the breeding ground, which may be several hundreds of feet above sea level and



SALMON REPLENISHMENT

Although the salmon industry in Britain is not to be compared with that in, for example, Alaska, great care is taken in the stocking of rivers for the purposes of sport. In the above photograph salmon eggs collected from a breeding stream are seen ready packed for transport to ill-stocked waters. About 100,000 eggs can be packed in one of these cases, the eggs remaining in good condition for several weeks if kept cool.

READY FOR FIGHT

Just before the spawning season the male salmon develops a hooked formation on the lower jaw, which serves him well in his struggles with rival males for the female of his choice. Immediately after spawning this formation begins to disappear, and the mouth reassumes its symmetrical shape before the fish regains the sea.

perhaps covered by only a few inches of water, the female salmon excavates for herself a small pocket in the gravel known as a "redd," where she at once deposits a few hundred of her eggs. With a flick of her tail she covers the eggs with fresh gravel and makes a new redd, when the process is repeated. Her mate is following close behind, and before one lot of eggs is covered up he secretes the sperm which finds its way into and fertilizes the spawn.

THE eggs take from a month to five months to hatch out, according to the conditions prevailing. If the weather is very warm and the waters of the stream are well oxygenated, only a few weeks need elapse, while in the colder parts of the country and in slow-running streams the process may take very much longer. The development of the egg through its successive stages is almost identical with that seen in the case of the trout

'PARR' AND 'SMOLT'

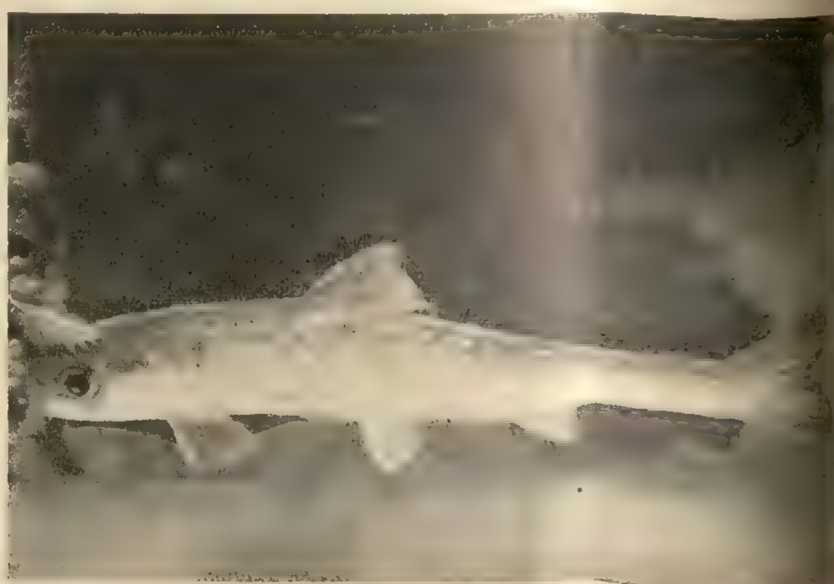
On the right we see a young salmon at the stage when it is known as a "parr"; it is about four inches in length and possessed of a darker coloration than the mature fish. The photograph below shows a "smolt" about three years old; its "parr" markings have been lost and it has assumed a silvery appearance.

(fully described in pages 98 and 99), and the young salmon breaks through the tissues of the outer egg covering and enters upon its life provided with a large yolk-sac, from which it draws its nourishment for several weeks. The baby fish is thus able to grow accustomed to a life in the stream before it has to set out and find food for itself. During this stage, when it is known as an "alevin," the fish remains in the upper reaches of the river and spends much of its time buried in the gravel at the bottom. After about a year it is called a "parr," and has an olive coloration with the back dark and the sides barred and spotted, and the underside white. About six months later—that is, in the second spring or summer—the back assumes a bluish tint, while the sides and under parts become more silvery.

First Travels of the "Smolts"

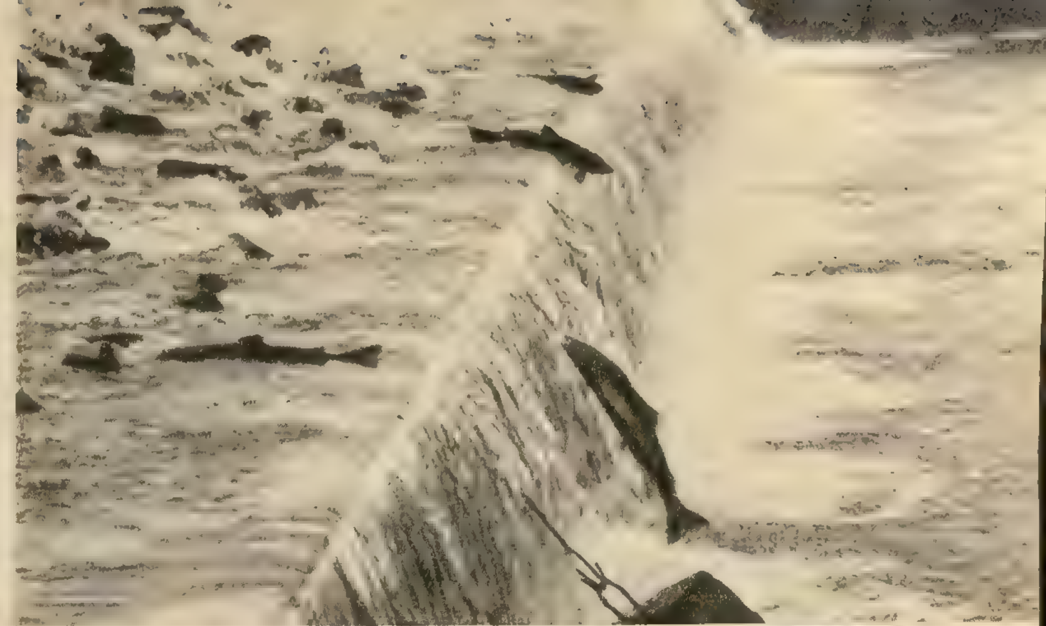
AT this stage the young salmon are known as "smolts," and, leaving the narrow streams where they were born, they drop down with the current into the slow-running waters of the broad rivers. Here they congregate in large numbers before they start on their long journey to the sea which is to be their home.

Up to now they have fed solely upon worms, insects and other small fry and are rarely to be found longer than about five inches. Now, however, although very little is known about their life in the sea, it is that they change their appearance and become the full-grown salmon or "grilse" which are observed perhaps some years later making their way to the breeding grounds. Fish that have once been up to breed and have managed,

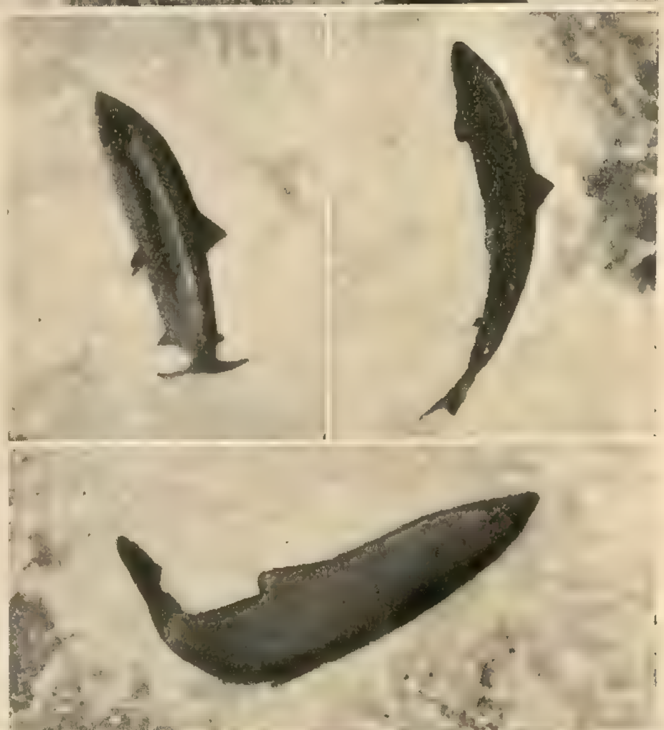


spent and haggard, to get back to the sea to be "mended" or restored to good condition, are known as "kelts"; these are mostly sexually mature males, for the females find it much harder to survive.

So little is known about the salmon that many fishermen of long experience have been led to believe that the salmon trout is nothing more than a young salmon, and they are so much alike in appearance that they are often confused. There are, however, certain numerical characters—the number of scales in the lateral line, for instance—by which, according to Dr. Tate



Regan, they may be identified. Because the salmon lives in the sea and is, therefore, able to obtain food composed of many more small crustaceans and planktonic forms of life, its scales are tinted with much lighter colours and have a more silvery appearance than those of the trout; they are, in fact, much smaller and may easily be removed with the finger. In the young salmon the fatty fin found just in front of the tail on the back of the fish, which is such a notable feature of the Salmonidae, is of a slaty-grey colour, while in the trout it is more or less tinged with bright red. The young salmon has also well defined black markings on the back, which form perhaps one of the most conclusive proofs of its identity.



Some Salmon Statistics

SALMON may, of course, be caught at all stages of their development. Large salmon range from about 4 ft. to as much as 5 ft. in length and may weigh anything from 20 to 40 lb., though occasionally they have been known to turn the scale at 50 or even 60 lb. Like trout-fishing, salmon-fishing is undoubtedly an art which can be acquired only with almost unlimited practice. The actual technique of casting, or flicking the fly on the end of a line on to the water, is much the same for both fish; it is in the choice of flies, rods and tackle and fishing ground that the expert salmon fisherman is revealed.

It is while the salmon are engaged in their upstream journey that they are caught by the fishermen, both with rod and tackle and, in some parts of Ireland and Scotland, with nets. In the past sportsmen often made it a practice to take snapshots with a gun at the salmon while the fish were leaping the falls, but with the tightening-up of the fishing laws this means of catching the fish has been almost entirely abandoned.

But most visitors to the salmon districts will be more interested in watching the fish than in fishing for them. A great deal of sport may be got from taking camera snapshots of leaping salmon, and such wonderful pictures as those reproduced in this page make a prize quite as much worth having and exhibiting as salmon carcasses in a glass case.

SALMON ATHLETES

All the salmon shown in the photographs on this page are fighting their way upstream towards the spawning grounds at the head of the river. In the top picture, quite a high waterfall has to be negotiated, and although many of the fish have reached the calmer waters beyond, some are being washed back and will have to make another attempt. The centre group of three pictures shows the salmon at various moments during its leap, while in the bottom photograph four salmon are making quick work of rapids.

Photos, R. Clapperton; A. Brook

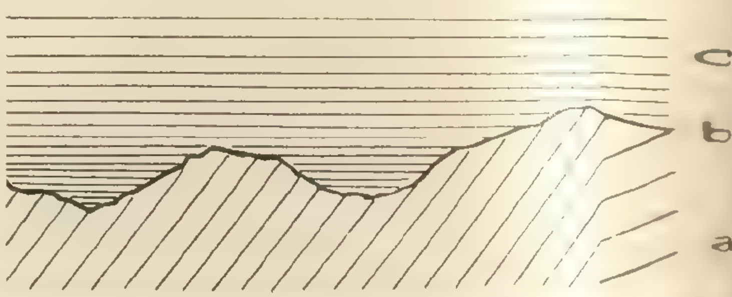
CRACKS AND CRINKLES IN BRITAIN'S CRUST

TO such creatures of a day as ourselves the rocky envelope of our homeland seems eternally solid and enduring. When we study geology, however, we find—as is explained below—that contortions on a terrific scale, vast upheavals and as vast subsidences, have left their indelible mark on our land surface, and that the period of complete quiescence, if it ever comes, is not yet arrived

IN previous chapters frequent reference has been made to earth movements, and it is important to study these in some detail, for their effect on landscape has been considerable. It must be remembered that an earth movement is not necessarily the same as an earthquake, for it may take place over a long period of time and involve no sudden or catastrophic change. Had it not been for the elevation and subsidence of the continental masses which were alternately depressed below the level of the sea and raised above the surface, we should have no layers of sedimentary rock from which to glean so much of the earth's long history, and no record of the long extinct forms of life that once flourished on our earth and populated its seas.

The cause of these crustal contortions is obscure. Various theories have been put forward to account for the movements, local and extensive, gentle and violent, which have left their record upon our land. At one time it was thought that the cooling of the earth and its subsequent contraction caused the earth's crust to buckle up, much as the skin will wrinkle upon a drying orange, but the researches of physicists into radioactivity have thrown doubt upon this theory by discounting the amount of cooling that the earth has undergone. Many other explanations have been suggested, according to one of which the continents themselves have drifted apart, crumpling the strata and causing elevation and depression of the land masses in the process.

WHATEVER their cause, the effects of earth movements can be traced in many parts of the British Isles. Elevation of the land during comparatively recent times may be recognized by the presence of raised beaches of shingle and sand some distance above high-tide mark. Submergence is not so easy to determine, for it is possible to confuse it with erosion of land by the sea. Definite evidence that the land has sunk can be obtained where there are submerged forests, or peat and other terrestrial deposits to prove that the sea bed was a part of the land in the not far-distant past. Such submerged forests exist off the coast of Wirral, in Cheshire, Pendine, in Wales, and in parts of Cornwall, where the stumps and roots of old trees stick out of the water at low tide.



BROKEN SEQUENCE

In the diagram (right) is illustrated a typical "unconformity," where a = the old land surface, b = unconformity, and c = new strata. Below, is a photograph of the cliffs of Arkle, near Scourie in Sutherland, where cliffs of Cambrian quartzite rest unconformably, along the line *b—b*, on Lewisian gneiss.

W. F. Taylor

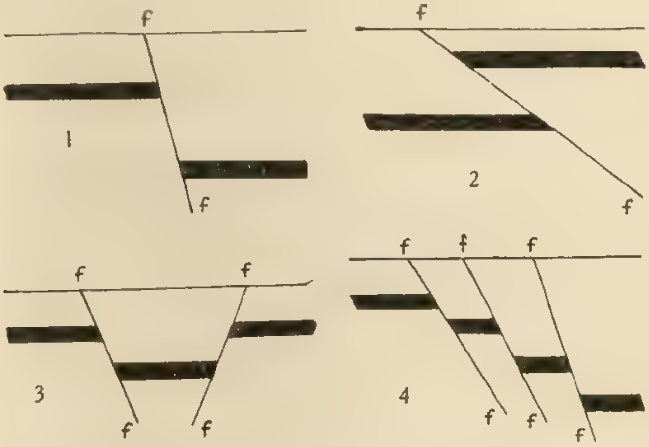
Geological Survey

ROCKY DISPLACEMENTS

Left, a cliff-face near Exmouth, showing a normal fault in which the rock to the right has *slipped downwards*. Right, a rock-face in Caithness illustrating a reversed fault. Here the rock on the right has been *thrust upwards*, bending and twisting the strata at the edges.

Another indication that submergence has taken place is the presence of an indented coastline—the west coast of Scotland, with its irregular coast and long sea lochs, being a typical example of scenery that has been affected in this way. The long lochs and arms of the sea, stretching into the land, were once river valleys, before they were drowned beneath the ocean. It is interesting to see that both elevation and submergence have taken place off the west coast of Great Britain within recent times.

SINCE such earth movements can be traced in our scenery, it is only reasonable to expect to see some effects of past movements in our rocks, and a careful examination will confirm our expectations. A sure sign that a change in the relationship of land and sea has taken place is that of *unconformity*. When an eroded land



'FAULTS' IN DIAGRAM

Four main types of faults are illustrated in these diagrams: 1, normal fault; 2, reversed fault; 3, trough fault of the rift valley type; 4, step fault; ff = the line of fault. The angle between the line of the fault and the vertical is known as the *hade*. The black lines indicate the displacement.

surface sinks below the sea, there will be a break in the rock sequence where the fresh strata are deposited. Such a break is known to geologists as an unconformity, and shows conclusively that an old land surface has become submerged. These unconformities can be seen in certain places where rock surfaces are exposed; some are small and of local origin, but big unconformities of wide distribution occur between the chief divisions of the sedimentary strata.

Unconformity, however, is only one of the signs of crustal movement. The disturbances that altered the balance of land and sea had also their effect upon the rocks. Movements occurred that built up mountain ranges and, in the process, folded, twisted and bent the rocks. These tears and curves in the structure are known in geological language as faults and folds.

Faults in the Earth's Surface

FAULTS are rents in the rocks. Under stress, strata may be torn, the line of division being known as the fault plane. On one side of the fault plane the strata usually slip down, though the displacement may occur in a horizontal rather than a vertical direction. Sometimes the rocks will sink down between two parallel faults, forming what is known as a trough fault, or a rift valley, an example of which crosses the south of Scotland, forming the great valley between the southern Uplands and the Grampians.

Often faults play an important part in underground weathering, since they afford a channel by which water may permeate the rocks more easily. Wherever there is a fault slipping may re-occur, and with each slip there will be an earth tremor, varying in intensity according to the

Byron Scott

CRUMPLED CLIFFS

Contortions in the rocks may be seen in many places in the British Isles. Lulworth Cove, near Weymouth, in particular, shows a fine example of folding, where the Purbeck and Portland beds have been crumpled by earth movements in the past.

UPRAISED BEDS

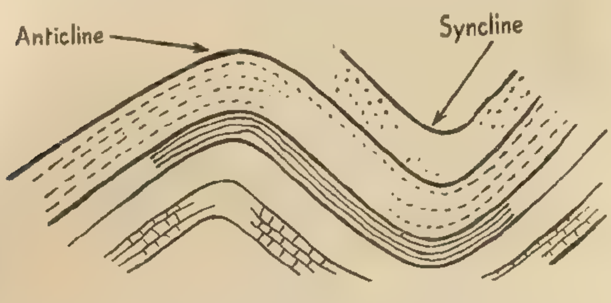
Sometimes in the limb of a gigantic fold the strata will [illegible] in a vertical instead of a horizontal position. An exa[illegible] seen in the photograph below taken near Warren, on the P[illegible] coast, where the thin-bedded, carboniferous limestone depo[illegible] been pushed up into an almost vertical positio[illegible]

length of the fault and the amount of slip. There is a famous fault in the west of England, known as the Church Stretton fault, which has been the cause of some of the slight earth tremors that have been felt in the British Isles. Luckily, however, Great Britain is placed nowhere near those regions of the earth's crust which are now under considerable stress, such as the Pacific earthquake belt, and so is free from anything in the nature of violent and catastrophic disturbances.

Tilting of the Rocks

In addition to faulting, rocks are subject to tilting and folding. Tilted strata are commonly found; indeed, it is comparatively rare to discover rocks that are quite horizontal. The very movements that raise the strata from the sea floor have nearly always tilted them in the process, and, if the rocks are of great age, subsequent movements will have moved them still farther from the horizontal, and may even have made them occupy a vertical position.

The more extensive movements will buckle the strata, and such folding will be visible where rock outcrops of this type are exposed. The commonest folding is that of a series of arches and hollows, alternating one with the other, and these folds are known as *anticlines* and *synclines*. The preservation of our British coalfields is due to such folding, for the coal basins occur in the hollows of the synclines, all the remainder of the formation having been worn away by erosion in the past.



OPPOSITE SLOPES

Typical folding is exemplified above. The strata are bent into a series of undulating folds, those that are arched upwards being known as anticlines, and those with a trough or depression being termed synclines.

It was mentioned in the introductory chapter of this series (page 30) that some of the oldest and most highly altered rocks occur in the north-west Highlands of Scotland, and it is here, also, that some of the most extensive earth movements have taken place. Some of the folds have been thrown over so that one limb of the fold lies with the order of its strata reversed. In other parts the rocks have been faulted and some of the older formations pushed up and thrust over the younger ones; in such cases the plane along which this thrusting occurs is known as the thrust plane.

When it is realized how extensively folding and faulting affect the position and direction of *dip* or slope of rocks, it will be clear what an important part earth movement plays in the formation of a landscape. The reason for certain rocks outcropping or occurring where they do, the shape of a coastline, and the position of valleys, mountains and plains may all have their origin in crustal disturbances that took place many millions of years ago.

Geological Survey

BUCKLED STRATA

Saundersfoot on the Pembroke coast shows a typical anticline with steeply inclined limbs. An equally sharp syncline underlies the hollow to the right. In the foreground the fold has been eroded by the sea, and the whole illustrates the problems with which the geologist has to deal when mapping strata.

STUDYING FAULTS AND FOLDS

Examine an outline map of the British Isles and notice the indented portions of the coastline. Remember that these inlets of the sea are drowned valleys and indicate that submergence of the land has taken place. When on a holiday by the sea, particularly on the west and south-west coasts, keep a look-out for submerged forests and raised beaches. Be careful not to confuse a storm beach, a bank of shingle piled up during bad weather, with a raised beach. Raised beaches occur from 25 to 200 feet above sea level.

Examine rock surfaces for signs of earth movement. Nearly any series of strata will show some deviation from the horizontal. Watch for folding and identify anticlines and synclines. Big-scale folding can best be discovered by mapping or drawing sections from existing maps. Folding will be found most extensively in the west and north of the British Isles, amongst the older sedimentary rocks. Try and discover signs of unconformity. If two series of strata, lying one on top of the other, are not parallel, there has probably been a long gap in time between their deposition. Sometimes the lower rocks will show signs of having been an old eroded land surface.

Faulting is not, as a rule, so easy to discover as folding. Only where there is very distinct banding in the strata can the slipping be seen at all easily, and even then the actual line of fault may be obscured by a stream. If a vertical or slightly inclined plane is seen in the rocks and additional evidence of its nature is required, the space between the two sides of the crack should be examined. If the space is filled with angular fragments that have been broken off from the sides of the rock, the crack is most probably a fault and the fragmental rock is a *crush-breccia*.

If the reader is lucky enough to spend some time on a tour of the north-west Highlands of Scotland he will have plenty of opportunity of seeing splendid examples of folding, faulting, and even thrusting.

CHERRIES NO ORCHARD FENCE CONFINES

THE beauty of Britain's cherry orchards is justly famed, but the charm of the wild cherries generally remains unsuspected and their fame unsung. Yet there are those who maintain that the informal loveliness of the wild varieties is to be preferred to the more regular appearance of their cultivated cousins. Here we do not pretend to decide the matter; enough to point out and illustrate the merits of the wild cherries of hedgerow and woodland

ALTHOUGH everyone knows, by repute at least, the famous cherry orchards of Kent and Worcestershire, orchards whose show of blossom is one of the features of the English spring, comparatively few people realize that we are fortunate in possessing also several species of wild cherry, each of which can make as fine a show of blossom as any of the cultivated varieties. Though not especially common in most localities, the wild cherries are found in most parts of the British Isles, growing usually in the woods or hedgerows. Of the three varieties found in this country, the largest, as well as the commonest, is the gean, often called simply the wild cherry.

All the cherries are very near relatives of the wild plums, which include the sloe or blackthorn, and, with them, are members of the great rose family, *Rosaceae*. One of the most interesting points about this order is that almost all its members have very noticeable fruits, according to the nature of which the order is partly subdivided. In the cherries the fruit is of the type known to botanists as a *drupe*. A drupe is a fruit that consists of a single seed (often known as the kernel) enclosed in a hard case (the stone), which is itself surrounded by a succulent and fleshy pulp contained within a thin outer skin or cuticle. This type of fruit is common also to the plum, peach and many other table fruits. In the apples and medlars the fruit is known as a *pome*, in which the fleshy or mealy part, made from the enlarged base of the calyx, encloses a number of seeds, each within a little cell. The strawberries, a further example of the fruit found in this order, have a large number of seeds embedded in a fleshy receptacle. The rose itself bears its seeds in neat rows inside an enlarged calyx-tube of a totally different type from that of the apple.

IN WINTER'S GRIP

The erect, virile growth of the common cherry, or gean, as it is more frequently styled, is seen to better advantage during the leafless winter season than in summer, when its boughs are clothed with abundant greenery. Straight branching and a pyramidal outline are typical of this tree.

E. J. Hosking

Of our wild cherries the gean is not only the commonest but also the finest. As a tree it may grow to a height of forty feet, having an upright trunk with a number of rather short, strong lateral branches, all of which grow upwards at a rather steep angle. The leaves are longish, much serrated, and of the form known as obovate; the points of the leaves, however, often grow curiously outwards. The leaves are downy on the underside.

Gean's Glorious Blooming

THIS tree flowers a little earlier than do the other wild cherries, for its masses of blossom first appear in April before the leaves are fully grown. The sight of a wild cherry tree, raising itself for forty feet or more among its neighbours in the thick woods, and covered with the fine white flowers that grow almost direct from the rough twigs, is one of the loveliest that our woods can show. The manner of inflorescence is what is known as a sessile umbel. An umbel is a form in which the flowers are on stalks arising from the top of a common stem; when the stem is absent, the umbel is said to be sessile, and the flowers arise in a bunch direct from the twig. The flowers of the gean have five petals and five sepals, with a large number of stamens. The anthers and stigmas mature simultaneously, thus allowing self-fertilization to take place. In this fact, as well as in the nature of the flowers, which are very wide open to the air, we see another provision of Nature to ensure the

A. W. Dennis

CONTRASTED BLOSSOMS

A woodland, rather than a hedgerow tree, the common cherry, or gean, provides us with wonderful blossom (above). The flowers, white in colour and wide open to the winds, hang on long, delicate stalks. The bird cherry (whose blossom is seen on the right) is confined to the northern half of England. Both its flowers, which are borne in long racemes, and its leaves, are readily distinguishable from those of the gean.

perpetuation of a tree that flowers early in the season when few insects are about.

As for the fruits, they are similar in shape to those of the cultivated variety, but much harder and smaller, being very bitter to the taste and quite uneatable. Birds, however, are very fond of them ; and certain cultivated cherries are said to have been bred from the gean. The leaves are reddish when very young, this colour adding to the beauty of the flowers early in the year, and in autumn also they assume a very fine red colour, which makes the tree once more an outstanding feature of the woods. They always droop downwards from the stems, thus giving the tree a certain grace at all times.

The attraction which the fruit of the gean has for birds is shared by the other wild cherries—to such an extent, indeed, that the second of our species is known as the bird cherry. This is a tree of smaller dimensions than the gean, and one that differs in several other important points. In height it is seldom more than twenty feet, and the bark of the bole is smoother and less cut up than that of the larger tree. The leaves, moreover, are broader, and the serrations are finer ; the same curious pointed tip is, however, frequently to be observed.

The flowers of the bird cherry grow in the form known as a raceme. This is an inflorescence in which the flowers grow on short stalks at intervals all the way up a common flower stalk, and is one of the most frequent types found in plants. These racemes, in the case of the bird cherry, are borne on lateral stems of new growth, not direct from the old stems as is the inflorescence of the gean. The petals, which are five in number, as in the gean, have uneven edges. The stigmas mature before the anthers, so that cross-fertilization becomes a necessity. The bird cherry is not so widely distributed as the gean, being, in fact, confined to the northern half of England as far south as Leicestershire.

Of the species found in the British Isles the third is the dwarf cherry, which can hardly be classed as a tree, since it rarely exceeds a height of eight feet. The leaves are similar in shape to those of the gean, but are of a much darker blue-green colour, and the serrations of their edges are rounded. The branches are weak and of

GEAN DRUTES

The fruits of the gean are smaller than those of the cultivated variety of cherry. Very bitter to the taste, they are eaten with avidity by birds, but are unfitted for human consumption. This picture shows the characteristic shape of the leaves, with their serrated edges and pointed tips.

A. W. Dennis

A. W. Dennis — E. J. Hosking

WILD CHERRIES IN WOODLAND AND PARK

Two cherries—but what a contrast in their boles! Time and the weather have dealt hardly with the one on the left, and its bark, typically marked with small splits running around the trunk, is contorted and split in a vertical direction. The tree on the right has evidently grown in much more favourable surroundings, sheltered from the unkind elements; and its straight and regular bole, though perhaps less pleasing to the aesthete, is of the form that brings pleasure to the timber merchant, for such finely-grown cherry is hard to obtain.

drooping habit, and a feature of the tree is that its roots send up a large number of suckers which give rise to more stems all round. It is perhaps owing to this habit that the dwarf cherry does not attain the true dignity of a tree. The flowers are very similar to those of the gean, but much firmer and less likely to suffer from the effects of the weather, which tears the petals of the gean. The inflorescence is of the same type of sessile umbel, but the individual flowers do not open so wide. The petals are notched on their outer edges. The dwarf cherry is a southern species, seldom occurring north of Yorkshire.

Cherry wood is extremely useful to the cabinet-maker, being hard, durable, and of a very beautiful reddish colour. It is seldom grown in large enough quantities to have any great value, except in the manufacture of furniture and of pipes and musical instruments, but young shoots and saplings make fine walking-sticks if the bark is left on and polished.

HINTS ON WOODCRAFT. 1

The art and practice of woodcraft is as old as Man, and it is an art which can be acquired only by long experience; there is no school except the open air, no teacher other than Nature herself. Some fortunate people acquire a knowledge of the signs and clues of Nature almost by instinct; others may live for years in a country that is full of birds and beasts and other creatures without perceiving more than a fraction of what is going on around them.

It is possible, however, by making use of the knowledge and experience of others, to learn the bases of this fascinating study, and of recent years great steps have been taken in bringing the ways and means of learning woodcraft nearer to the person who is born and bred in the town. The chief of these is the realization, now general, that watching and observation are of far more value than collecting. This applies to all classes of natural objects and creatures, and it is from this point of view that the present series of notes on woodcraft is written. Given observation, the sole equipment required is a notebook and a pencil.

A pair of field glasses and a camera may also be taken, and the former are especially useful in bird-watching and on occasions when the naturalist is in open country or must watch his quarry from a distance.

There are two main ways in which to set about the observation of Nature. One is to sit down, very quietly, in a certain spot and wait for something to happen; the other is to walk about and note everything that you see. Each of these has its advantages. Whereas the person who sits and waits may make a complete series of observations on one particular bird or animal, or have a front seat in some drama of wild life, the man who wanders about, using eyes and ears as he goes, will probably see and learn more in a given time.

Know What to Look For

This is our first rule of practical woodcraft; it is never worth while to sit down and wait for something to happen unless you know what you are waiting for and are reasonably sure that it is going to happen.

In the case of a situation in which we have decided to watch at one spot for one single bird or animal, there is little to do except sit and watch, although anything else that can be observed from the spot should be noted. When we are wandering from place to place, however, there is almost too much to notice. Besides the many flowers and other objects that strike our eyes, and which we are able to note in passing, there will sooner or later be something that is especially new or striking.

Say, for instance, that we find beneath a tree a mass of leaves that have obviously been eaten off, or say that we can see that there are caterpillars or other creatures at work doing great damage to the foliage.

Studying an "Association"

This at once brings us into contact with a series of events and an association of creatures connected, more or less directly, with the present situation. We may collect a few of the caterpillars, taking them home for identification; a few sweeps of the net, if the branches of the tree are low, will bring us a number of curious little insects, like tiny black wasps or flies. These are parasitic flies or ichneumons, attracted by the easy prey, and if we are fortunate we may watch them at work, stinging the hapless caterpillars and laying their eggs in their bodies, or carrying them off, paralysed, to stock their burrows.

Higher in the branches small birds such as tits and warblers will be fluttering to and fro, picking the caterpillars and other insects daintily off the leaves, not stopping to worry whether they are eating victims or parasites, but merely taking advantage of the plenty to feed themselves and perhaps also to take a meal home to their families.

Round the base of the tree, weakened by defoliation, boring beetles, quick to take advantage of its misfortunes, are adding their numbers to the attacking forces. Thus from noticing the scarcity of leaves on a single tree we can fill many pages with notes.

OUR HALF-DOZEN SNAKES AND LIZARDS

FEW reptiles—only six, in fact—are to be found within our shores today, although in the far-distant past reptiles of huge size and fearsome aspect roamed the land and splashed in the warm coastal waters. The chapter that follows is in the nature of an introduction to the study of Britain's reptilia, detailed examination of the individual species being reserved for later chapters

THE theory of evolutionary history which Darwin propounded during the last century, although it has undergone considerable alteration since his time, has undoubtedly made the work of the writer on Natural History considerably easier. It must have been well-nigh impossible before Darwin's time to think of the animals other than as disconnected species, for without the underlying hypothesis that they have all evolved from a minute and lowly common stock, it would be extraordinarily hard to consider them as a whole.

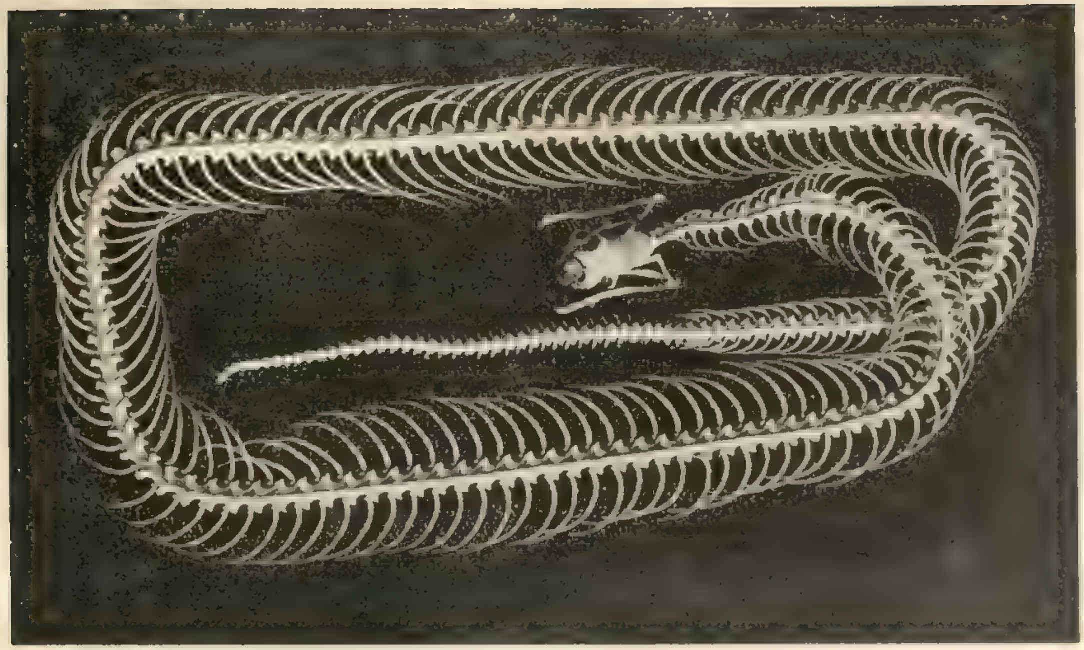
The link between the amphibious animals, that is, those that live on land and in water, and the purely land-living mammals is to be found in the class known to naturalists as *Reptilia*. This is divided into five orders, comprising respectively tortoises and turtles, the New Zealand lizard *Sphenodon*, lizards, snakes, crocodiles and alligators. Some snakes and lizards only are found in Britain, where the climate is really unsuitable for the existence of the reptilian type of animal, and of these only six species, three snakes and three lizards, are represented. To those who have no knowledge of Natural History the distinctions between amphibians, reptiles and mammals are often a complete mystery, and the trained naturalist finds himself astounded at the muddled rough classification which is popularly accepted. The story of the old woman who arrived with her pet tortoise on the railway station is typical. When the ticket-collector warned her that she must pay half fare for animals, she exclaimed: "Oh no, dogs and cats is animals, but tortoises is insects!"

From a scientific point of view every living thing which is not a plant is an animal, a term that includes, of course, protozoa, fish, amphibians, reptiles, birds and mammals. The reptiles provide the naturalist with the link that he requires to complete his history of the evolution of life from the sea to the land, and also throw light on the problem of the origin of the birds. When the crawling reptiles first took to the land, they not only burrowed into the ground and slithered over its surface, but climbed into the branches of trees. Some of them found that an arboreal existence proved an advantage when faced with the perpetual problem of finding food and keeping in safety. Here as yet a sadly needed link is missing, but anatomical and physiological evidence is sufficient to make naturalists believe that the birds formed their feathers from the same material as the scales of the reptiles and eventually took wing in the air.

SNAKES HATCHING OUT

Many people will be surprised to learn that some, indeed most, snakes come out of eggs. This picture shows a number of baby grass snakes looking out on the world for the first time. The eggs from which they are emerging are made of a parchment-like substance, and arranged in a string which breaks soon after birth.

Berridge



Evidence in favour of this theory has been several times put before the scientific world, when on the dissection of dead snakes it has been found that perhaps three or four mice have been swallowed and only half of the first one has been digested. In order to cope with this swallowing of large bulks the mouth-parts of the snake have been specially adapted and the maxilla or jaw is attached to the skull by means of extraordinarily elastic muscles. When the snake opens its mouth to swallow something that is perhaps far larger than its own head the jaw is able to stretch to a sufficient extent to allow of the passage of the prey into the gullet. We often see pictures of snakes swallowing eggs whole, and there are numerous accounts of field naturalists having observed quite small snakes "getting outside" comparatively large baby rabbits.

Among the most typical features of the snake are its poison fangs, of which so many people live in dread. The fangs themselves are not actually poisonous, but are attached by means of a duct to two glands on the back of the head which provide the noxious fluid. The snake bites, and does not sting as is often popularly supposed.

RIBS BY THE SCORE

The above photograph, taken at the Natural History Museum, South Kensington, is of an adder's skeleton. The number of ribs varies from 132 to 158. Naturalists skilled in comparative anatomy are able to find traces of limbs which suggest to the morphologist that the snake and the lizard had a common ancestor in the remote past.

Reptiles are not distributed over the entire British Isles, for there are no snakes in Ireland or in many of the smaller islands situated off the west coast of Britain. As an explanation of the absence of snakes from Ireland, there is, of course, the legend of St. Patrick, as a reward for having converted the Irish nation to Christianity, being allowed to rid them for ever of the symbol of evil. Naturalists, however, not content with the beautiful though somewhat hazy conceptions of mythology, attacked the problem from a geological point of view, and found that, although England, and, of course, Scotland and Wales, had at one time been attached to the snake-infested Continent, Ireland was already an island when the reptiles returned from the tropics after the close of the last Ice Age. It would, therefore, appear that the reptiles are not really—speaking in geological terms—indigenous to this country, although they arrived here many thousands of years ago.

Hidden Legs in Snakes

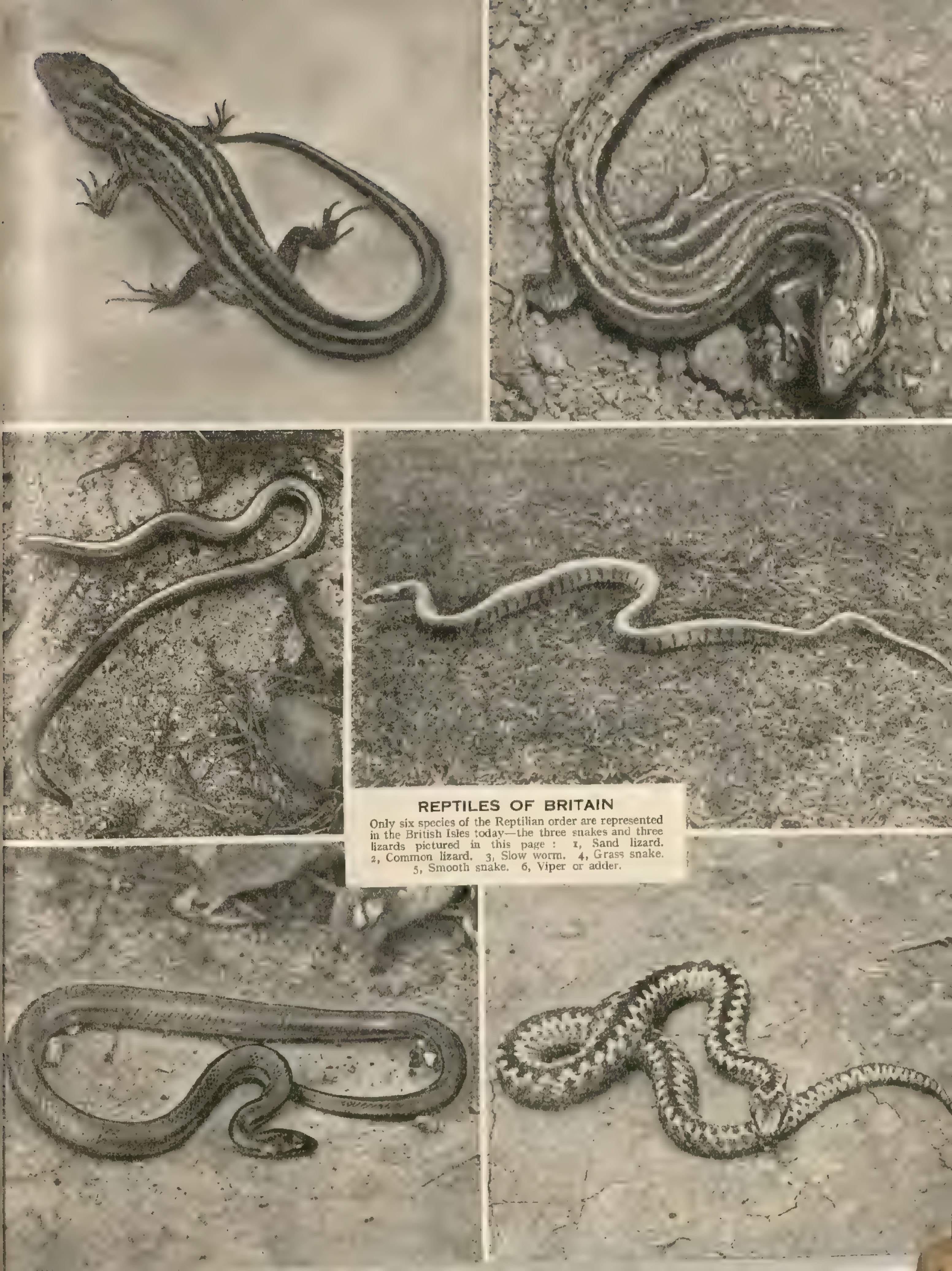
SNAKES are a newer edition of the reptile form than lizards, for they are the latest product in the history of reptilian evolution. Lizards are provided with four short legs by which they run quickly over the ground, while snakes, on the other hand, are apparently devoid of any appendages at all. Actually, however, an examination of the skeletons of some snakes shows that this is not the case, for under the skin may be found vestigial forms of legs such as appear in the lizard.

The alimentary canal of the reptile is particularly well-suited for the absorption of food in large bulk, and in the snake the oesophagus, which corresponds to the gullet in the human being, is so long that many anatomists hold that it is utilized to store the food which is allowed to pass gently into the stomach as digestion proceeds.

Britain's Only Poisonous Snake

ALL snakes bite, but by no means all snakes are provided with a sufficiently virulent poison to have any effect upon Man. There is only one British poisonous snake, and that is the adder or viper. The other two British snakes are completely harmless, and although they are capable of biting with their teeth they cannot inject any poison whatsoever. Apart from its colouring and general appearance—which are dealt with in a later chapter devoted to a consideration of this animal—the head of the adder is somewhat broader than that of the grass snake with which it is often confused. This broadness of the head is due to the presence of the enlarged poison glands on either side of it, and is found in an exaggerated degree in many of the deadly poisonous tropical varieties.

In some snakes the poison fangs are connected with the glands by a duct which under pressure delivers the poison in small drops at the root of the fangs. The poison then runs down a groove in the fang and is thus injected into the wound. In the adder, however, the groove has been closed in to form a duct which runs down the centre of the tooth and delivers the poison through a hole just above the tip. Snake poisons are similar, from the chemical point of view, to such bacterial poisons as those produced by the tetanus and diphtheria germs. Ricin and abrin are other vegetable examples of this same class of deadly



REPTILES OF BRITAIN

Only six species of the Reptilian order are represented in the British Isles today—the three snakes and three lizards pictured in this page: 1, Sand lizard. 2, Common lizard. 3, Slow worm. 4, Grass snake. 5, Smooth snake. 6, Viper or adder.

Neville Kingston

SLITHERING SHAPES

Few people can look on a snake, still less on a mass of vipers and grass snakes such as is seen in this photograph, without an instinctive sense of revulsion. Why this is so is difficult to determine, but possibly it is attributable to the fact that for thousands of years the snake has been regarded in many parts of the world as the emblem of evil subtlety.

toxins. The well-known South African naturalist, Mr. F. W. Fitzsimmons, has spent many years in investigating the effects of snake-bite and in endeavouring to discover a really efficient anti-toxin. Perhaps the best method yet discovered to prevent the rapid spread of the poison throughout the system is the immediate application of a violent oxidizer, which will not only oxidize the affected tissues but also convert the poison into a non-poisonous form. The simplest and most effective method of guarding against the danger of snake-bite is to carry a small phial of potassium permanganate crystals, which may be applied to the wound and will rapidly have the effect of counteracting the poison.

Fear of snake-bite in this country, however, is really quite unjustified. Since the time that careful records have been kept there have not been more than about a dozen deaths, and hundreds of examples are recorded by the medical authorities of people who have been bitten by adders and have survived.

Heat is undoubtedly one of the greatest attractions to any form of reptile life, and all reptiles in Britain go into hiding during the winter months. The majority of snakes and lizards reproduce their species by laying eggs, usually in strings of a parchment-like material, but the viper is generally said to be viviparous, bringing its young into the world as small editions of the parent. This, however, is not always the case, for after a warm winter and a sunny spring female adders have been known to produce a string of eggs which have ruptured a few minutes after being "laid."

THIS fact, like many others in connexion with reptiles, has provided an interesting link in the history of evolution, for here we see the halfway house on the road to the development of the true viviparous animals. The mammals are at the end of the journey, and have evolved a means by which not only the developing egg, or embryo, may be retained within the body of the parent until birth, but by which the offspring may be fed by the mother on specially-prepared food (milk) until they are capable of digesting more solid sustenance.

In later chapters in this series the six British species of reptiles are dealt with individually, and their characteristics and life histories explained in full.

Revealers of Nature. 7

SIR ARCHIBALD GEIKIE

BRITAIN has produced many great geologists, and among the greatest was Sir Archibald Geikie, who did more perhaps than any other man towards forwarding the science of geology in the British Isles. Not only was he famous for his own research work, but in his organizing capacity he did invaluable work in directing the Geological Survey, while his literary tastes and artistic appreciation of scenery made him eminently suitable as a popularizer of geology for serious students.

Born in 1835, Geikie was lucky in having Scotland as an early training ground, for the ancient and varied rocks of that country produce some of the most difficult and interesting problems in field-geology. He made good use of his opportunities, and, entering the Geological Survey at the age of twenty, he became a director twelve years later. His career was a distinguished one. He was first Murchison Professor of Geology and Mineralogy at Edinburgh from 1871 to 1882, when he became director of the Museum of Practical Geology in London, where he remained until 1901, his main work being the directing of the Geological Survey of the United Kingdom.

The most important of his writings is his "Text Book of Geology," first published in 1882, which is a comprehensive work on geology, invaluable to students and all those interested in the science. His other works include the "Story of a Boulder," 1858, and "Scenery of Scotland," 1865, books on ancient volcanoes in Great Britain, scenery and its influence on history and literature, "Scottish Reminiscences," 1904, and his autobiography, "A Long Life's Work," 1924.

The debt that Great Britain owes to this famous Scottish geologist may be more fully appreciated when it is realized what tremendous work lies in the making of a complete geological map; and the fact that the British Isles are now covered by a comprehensive series of maps which have been surveyed and planned by a staff of expert geologists, working in the field, must be largely credited to the enthusiasm, energy and organizing ability of Sir Archibald Geikie. The unravelling of our island's long and complicated history could only have been done with the aid of such a complete survey, and though there are many great problems still to be elucidated, and important gaps in the geological history of our land, the main work of geological mapping has been carried out by the survey of which Geikie was a director.

His exceptional talents and wide sympathies made him a man well suited to his work. Not only did he make the public aware of the importance of knowing something of the material of which their land was made, but he also opened the eyes of his brother geologists to the necessity of studying the work of foreign experts both on the Continent and in the United States, so helping to internationalize the science. He was knighted in 1891, and given the O.M. in 1914. He died on Nov. 10, 1924.

HAWTHORN-TIME IN THE COUNTRYSIDE

ONE of the most delightful periods of the year is when the promise of spring has not yet developed into full-blooming summer. In England we call it hawthorn-time or May-time, after its most characteristic flowering, and below, in the third chapter of the "Seasons" series, we learn of the varied features of the ever-popular hedgerow tree and also of some of the little creatures that find in it a home

HAWTHORN-TIME has come again, and with it masses of snowy blossom crowning the trees in the hedgerows and starring the downs and commons —blossom so abundant and so lovely that in popular speech it has been given the name of the month—May—in which its glory is most apparent.

Many other delightful characteristics of the season are in evidence. After the comparative silence and inactivity of winter, flowers and birds and insects are once more everywhere to be seen. Nature has awakened, and is now becoming more and more amply occupied with the task of preparing for the fuller delights of summer and the final fruiting of autumn. In the pine woods the air is heavy with the smell of resin and the yellow powdering of the winged pollen. The river meadows are ablaze with the lilac and gold of the lady's smock and the marigolds, which find their floral counterpart in the bluebells of the woods and the cowslips of the chalk downs. The butterflies, too, are out and about, dancing their way over flower border and rockery, over meadow and heath, and in the evenings we may begin to hear that heavy hum which shows that all the myriad other tiny insects are busy, fertilizing the flowers, laying their eggs, and buzzing merrily about their work. The honey-bees are swarming, too, and every hive is active with the strong rush of energy that shows that spring is more than half advanced and summer is not so far away. Bird-song at dawn is loud enough now to awaken us at an unaccustomed hour, and all our avian friends re-echo in jubilant tones the message that the hawthorn conveys to our eyes. . . . Maytime is here.

NOW let us study in detail the tree—sometimes it is but a bush—which is perhaps the most prominent feature of the Maytime countryside—the "May" or hawthorn.

Where the hawthorn grows as a tree it makes great mounds of blossom, showing well the rounded contour of its growth; but in many parts of the country one may travel for miles without ever seeing it as more than a hedgerow shrub, cut back every year to form at once an

GLORY OF THE HEDGEROWS

The May or hawthorn makes the best showing of all our hedgerow trees—not because of the imposing nature of its growth (for it is lowly in stature), but on account of the loveliness of its blooms.

W. F. Taylor

H. Bastin

SNOW-LIKE BLOOM

Bunched in great masses on the slopes of the downs, the hawthorn blossom reveals the rounded contour of the parent trees; from a distance the hillsides have the appearance of being covered with unseasonable snow.

impenetrable wall and a home for numerous nesting birds. Such hedges are indeed lovely when the plant is in bloom, and again when the fruits are ripe and red on the bushes, but to see the May at its best one must go to the downlands, where it is allowed to grow to its own characteristic shape. In woodland parts such as the New Forest it may reach as great a height as fifty feet, with a girth of nine feet or so around the base of the bole, and it is then a thin and rather straggling tree; but the distinctive shape, as has been said, is rounded, and the height ordinarily ranges from twenty to thirty feet.

The bark of the hawthorn is dark and rugged, greyish-brown in colour, and the wood is fine and hard; an interesting point in connexion with the growth of the tree is that it often grows some twelve feet in the first four years, and thereafter very slowly. On a windy hillside one may frequently see a very ancient, gnarled row of hawthorns, and there is no doubt that in such situations they live to a great age. Here, as well as in the hedgerows, the whole tree may be covered with a beautiful grey lichen, which adds a hoary appearance to the tree that is already somehow very reminiscent of an aged, weatherbeaten countryman.

"Haws" of the Autumn Hedges

HAWTHORN is a member of the rose family, and the flowers show many of the features that are characteristic of the common wild rose. There are five sepals, five petals and a large number of pink stamens. The flowers, which are borne in level-headed clusters, are normally white in colour, but occasionally trees may be seen whose flowers are of a more or less deep pink, and there is a very common garden variety with fine rose-red blooms. The fruits, which are the well-known "haws" of the hedges in autumn, are normally deep red in colour, but may occasionally be black or brilliant orange. These fruits are of much the same type as is found in the rose, but the fleshy outer part encloses a hard core, inside which the seeds are encased in little cells. This core resists the digestive juices of the birds which eat the fruits, and is consequently excreted after the pulpy part has been digested. In this way the hawthorn is spread all over the country.

Characteristics of the May

THE leaves of the hawthorn are divided into from three to five lobes, each of which is slightly subdivided. They are shiny on the upper-surface, and in late summer, when they are old and tough, gleam in the sunlight. The berries often ripen early, and a whole tree may show as a lovely mass of red if the leaves have not yet fallen but have already got their fine crimson autumn colouring. Later, when all the leaves are gone, the trees are lit with a darker red, and seem to glow with deep crimson fire in the warm light of the late autumn evenings. Birds are extremely fond of the haws, and the trees may be crowded with greedy blackbirds, thrushes and finches during the hard days of early winter. The thorns of the hawthorn are long and strong, as the culler of its blossom soon learns, and are borne both direct from the stems and at the ends of the small lateral shoots.

The plant gets its name, not from the fruits, but from the Anglo-Saxon word *haga*, which means yard or hedged place; this has been gradually corrupted to the form haw, and thus it is that the fruits are actually named after the tree. The derivation shows that the tree's quality of being a good hedge plant has long been recognized.

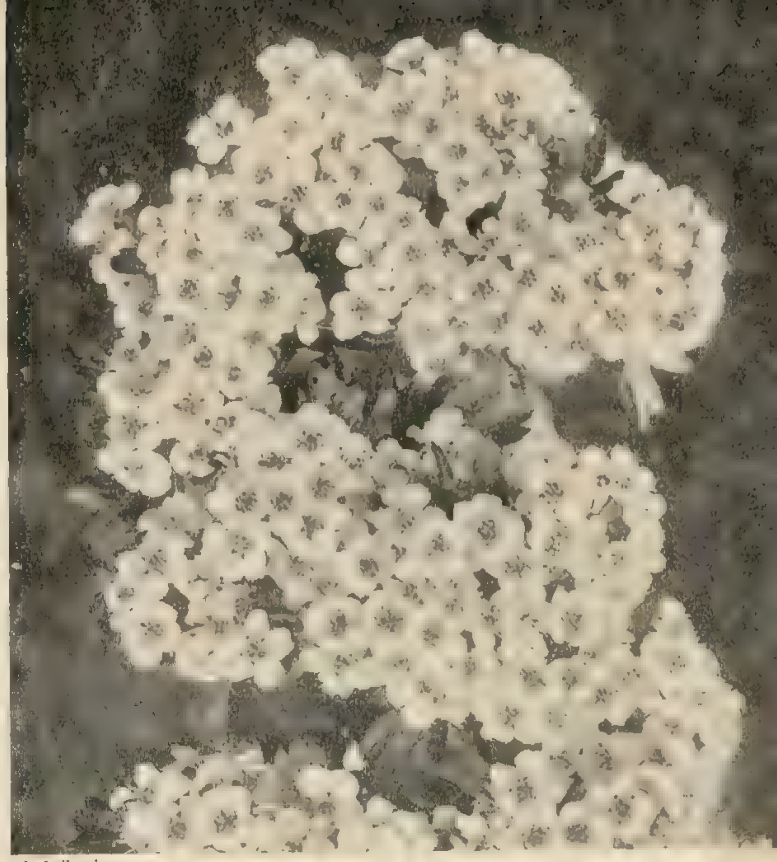
The names " quick " and " quick-set " are also applied to the tree when it is formed into hedges. It will stand very severe clipping every year, sending out innumerable small shoots which interlace and grow inwards so as to make a hedge so strong that any cattle will be kept well within bounds. At times such a hedge may be so thick that it is possible to walk along the top without fear of falling into the thorny mass below. The continuous browsing of cattle will often produce a similar effect in small isolated bushes, such as may be seen growing on common lands in the country.

Caterpillars in the Hawthorn Bush

As our most important hedgerow tree, the hawthorn is a host for innumerable caterpillars and other insects, besides providing a home for many different species of birds. Amongst the most interesting insects which live as caterpillars in the hawthorn is the lappet moth. This rather scarce moth, whose caterpillars feed also on other members of the rose family as well as on sallow, is of an extremely beautiful reddish-brown colour, often shot with a silvery-purplish tinge. The moth owes its name to its very curious caterpillar, which has a series of fleshy lappets or folds along the sides of its body. The ground

colour of the caterpillar is greyish, but it is more or less covered with black hairs, with a fringe of brown hair along each side. It may be remarked that when the caterpillars are found feeding on twigs covered with grey lichen they often have a number of white marks on the back which serve to make them even harder to distinguish than usual.

Many types of " stick " and " looper " caterpillar are also found on the hawthorn hedge, one of the commonest being that of the brimstone moth (not to be confused with the very different brimstone butterfly). This is a smallish caterpillar, and one which so closely resembles a twig that it is almost impossible to find it by deliberate search. It is brownish-purple in colour, a greenish tinge sometimes taking the place of the purple, and it has two humps towards the rear end of the body. The moth is a small insect of a fine, bright yellow colour,



J. J. Ward

THORN-GUARDED FLOWERS

The massed blossom of the hawthorn is so beautiful that every beholder feels impelled to pick a spray, only to find that there is no hawthorn without its thorn. The tree's hidden weapons are seen on the left, in the nakedness of early spring.

with a brown spot towards the tip of the fore-wings and two other smaller spots along the fore margin. Other " loopers " of the hawthorn are described in a later page.

Birds of many different species favour the hawthorn hedge. In a very high hedge, or in a well-grown single tree, we may find such birds as the jay and the magpie building. Wood pigeons and turtle doves make their flimsy nests lower in the branches, and in the thicker and more bushy trees of the hedgerow we find the nests of blackbirds and thrushes innumerable. The long-tailed tit is very fond of the thickest parts of the hawthorn hedge, for there the lichens with which it adorns the outside of its lovely rounded nest tend to act as camouflage, so that even the sharpest eyes may fail to detect the tiny bird's home. Where the twisted stems of a very old thorn hedge make deep cracks and holes we may find some of the other tits building, and the holes and cracks in the bark of ancient solitary trees attract a similar fauna. The herbage that springs up around the base of the hawthorn hedge in spring and early summer provides an ideal home for the birds of the warbler tribe. Whitethroats and blackcaps build in the lank grasses and stiff plants and among the brambles that grow every year around the roots of the hedge trees, and in the banks that support the trees robins and wrens find an ideal site. Where the herbage is especially thick we may find the domed nest of chiffchaff or willow warbler. Thus, although the hawthorn is chiefly worthy of our attention as a tree of great beauty at the most beautiful time of the year, to the naturalist whose interests are wide it is also attractive as providing a home for many fascinating and varied creatures.

TORTOISESHELL PEACOCK AND RED ADMIRAL

As may be seen by reference to the colour plate facing page 36, the butterflies mentioned above are exceedingly handsome, and they are so widely distributed that they are amongst the best-known and most admired of all our butterflies; even their names have an attractive ring. Together with the Comma and the Painted Lady they are included in a group rather loosely known as the Vanessids

PERHAPS the best-known of all our butterflies, the Small Tortoiseshell is familiar to dwellers in both town and country, for wherever there are gardens it may be found flitting from flower to flower, sweeping suddenly away into the air and gliding back with an occasional flutter of its brightly-coloured wings. In winter, too, it is a not unusual sight, its habit of hibernating on ceilings, in the folds of curtains and behind pictures or furniture making it one of the few insects that we can easily examine at close quarters. At the same time, many people who have wondered what this bright butterfly can be doing in the house in the winter, and have even inspected it carefully during its winter sleep, would fail completely to recognize it when it is in flight in the open air.

The Small Tortoiseshell is the commonest representative of the handsomest group of butterflies found in this country, the family known to entomologists as the *Nymphalidae*, and it is, further, a member of the important sub-family *Nymphalinae*. The members of this sub-family are mostly well-known to everyone, including as it does the Small and the Large Tortoiseshell, the Peacock, the Red Admiral, the Comma and the Painted Lady butterflies. These are closely related and are known by the general name of Vanessids. They are all characterized by brilliant colouring, strong and at times rapid flight, and a great fondness for brightly-coloured flowers, which brings them in large numbers into our gardens during the summer months.

A detailed description of the colouring of any butterfly can be of little value in the field, for there it is rather by a general impression of its coloration than by the exact number and arrangement of the markings that we recognize it. The following notes, however, will give some idea of the major characteristics by which the Vanessid butterflies may be identified. One point which they all have in common is the shape of the wings; the fore margin is straight, only turning very slightly towards the outer angle. The outer margins are irregular and scalloped, having a square corner to the fore-wing, with a slight point sticking outwards below the corner, and a similar projection about half-way along the margin of the hind wing. In the Painted Lady the wings are rounder at the corners, and in the Comma the outline is extremely irregular.

EATERS OF THE NETTLE

Living in great colonies of several score individuals, the larvae of the Small Tortoiseshell wreak havoc on the nettle plants. In their anxiety to secure food, they crawl over each other, as shown here, and weigh down the bridge of nettle stems. (× 2½.)

Gaumont-British

How to Recognize the Small Tortoiseshell

WHEN it is flying the impression given by the Small Tortoiseshell is that of a bright reddish-orange butterfly, this tone being the ground colour of the wings. The inner areas of the wings are dull brown; the margins are darker in colour, having all round the edge a number of little crescents of bright blue. On the fore-wings there are three black patches along the fore margin, with a white mark beyond the outer one and yellow markings between the other two; below, two small black spots have beneath them an orange spot, inside which there is a further black spot. The black spots on the fore-wings vary greatly in size; they may be entirely absent or they may coalesce to form a single black patch. The orange-red of the ground colour is also subject to variation, paling in some specimens to buff, without any tinge of red. The hind wings are plain, with a yellow mark at the fore corner of the dark brown inner area. The underside is in striking contrast to the upper surface, a feature which is common to all the Vanessids. When the wings are shut together in an upright position, the rear wings almost completely hide the fore ones. The inner area of the rear wings is a warm, speckled brown, outside which is a lighter

area covered with very small wavy brown markings. The margins have a series of zigzag black markings, and the fore part of the front wing, which is also visible, shows pale marks that correspond to the yellow marks on the upper surface. When the insect is settled

J. J. Ward

THE PEACOCK

Well worthy of its name is this butterfly exquisite, yet when its wings are folded (right) there is nothing to suggest its brilliant colouring (about natural size).

with the wings thus folded it is extremely difficult to see, resembling as it does a dry and wrinkled leaf, a likeness that is shared by all these butterflies when the undersides are showing.

Its caterpillar, which teeds on nettles, is actually yellowish in colour, but is so thickly covered with black dots and hairs that it appears much darker ; a feature, characteristic of all the Vanessid caterpillars, is that it bears a number of stiff, branched spines, which give it a prickly appearance. The Small Tortoiseshell is double-brooded, and thus the larvae may be found in late spring and early summer, and again in the late summer. The adults from the second brood hatch out from the pupa in late autumn and hibernate in houses or elsewhere under cover, to lay in the spring the eggs which give rise to the caterpillars that make their appearance in the summer that follows.

The chrysalis, which is suspended from the stem or leaf of a nettle plant, has two sharp points at the head. The larvae of this series of insects pupate in a rather different manner from that which is adopted by the Large White caterpillar (*see* page 39). A single pad of silk only is spun, and from this the insect hangs head downwards during the period of pupation, instead of binding itself more or less firmly to a flat or upright surface, as in the case of the Large Whites.

The Large Tortoiseshell is, as its name implies, similar in some ways to the insect we have just described, but it is common only in the southern half of the country. The wings are deeper from fore to hind margin, and the whole insect is considerably larger, while it has more bright reddish-orange in its coloration and less of other colours. There are only two black patches along the fore margin of the fore-wings ; the inner dark area of the hind wings is almost absent, its place being taken by a black spot, outside which there is a yellow patch similar to that of the smaller butterfly. The yellow patches on the fore-wings are smaller, and the black spots larger ; the lower black patch is often divided into two, and there is a third black spot in the outer, rear corner of the fore-wing ; and the blue crescents are almost absent in the male and always less noticeable than in the Small Tortoiseshell. The underside of the male is an almost uniform dark brown ; that of the female is more similar to the underside of the smaller butterfly. In spite of many points of resemblance the rambler who is lucky enough to come across the Large Tortoiseshell is not likely to mistake it for the small species on account of its size and colour. The caterpillars live in large companies, usually on elms, but also on willow and poplar trees, and it is in leafy lanes where elms abound that the insects must be sought, in July and August, and, after hibernation, in the spring.

A third insect that is at first sight very similar to a Tortoiseshell is the Comma, which is now classed by collectors as a member of a different genus from the other Vanessids. It may best be described as looking like a sadly faded and tattered Small Tortoiseshell, whose wings are of a uniform reddish-orange with brown markings. It derives its name from the brilliant white mark, shaped like a comma, that is to be seen on the undersides of the wings. This insect is dealt with more fully in a later chapter, as also is the Painted Lady, a further member of the same

RED ADMIRAL

Not from any nautical association is its name derived. "Admiral" is a corruption of "admirable," and admirable indeed is the insect in question (about natural size).

J. J. Ward

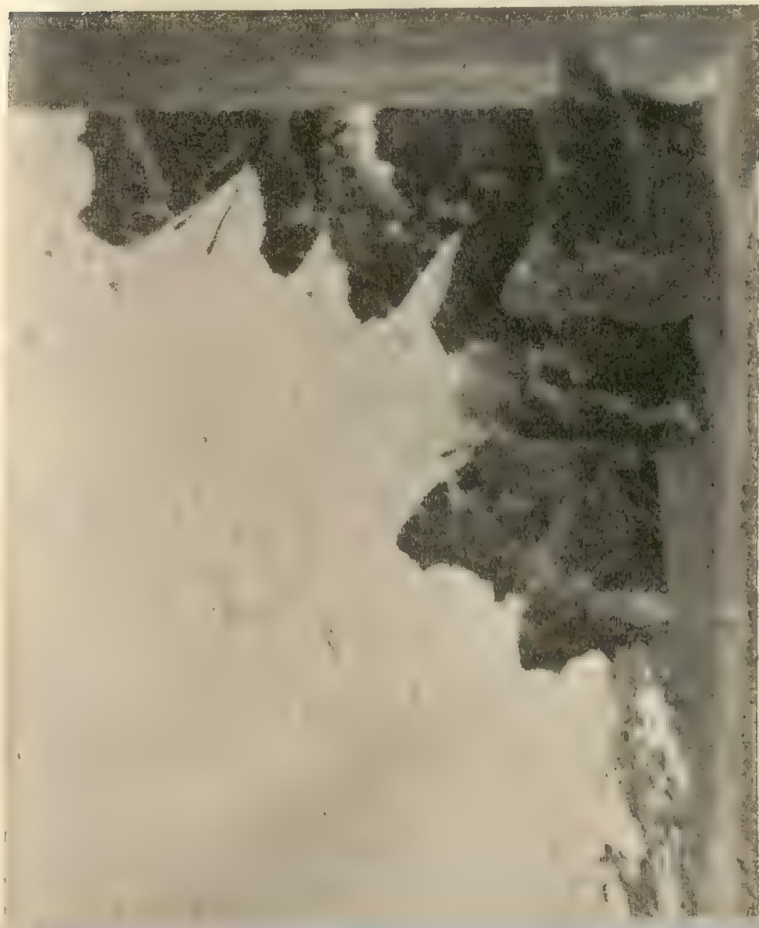
OPENING CHAPTERS IN THE TORTOISESHELL'S LIFE STORY

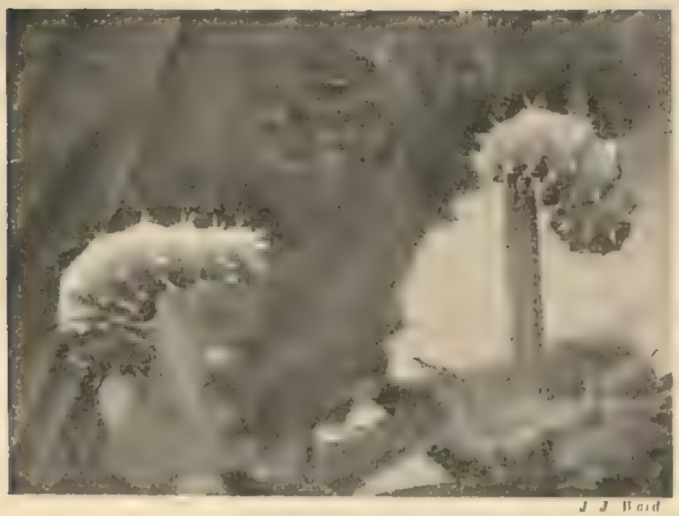
The eggs of the Small Tortoiseshell butterfly are laid in batches on the leaves of the common stinging nettle (left photograph above, [illegible] 8), and there the larvae live, keeping close company with the other members of their party until the time comes for pupation. When [illegible] wn, each caterpillar chooses a suitable spot on the stem of the nettle, and there weaves a silken pad, on which it hangs during the [illegible] to a chrysalis. This is shown in the right-hand photograph, above, the caterpillar being enlarged about ten times. Below, the left-hand picture shows the caterpillar (× **about 2½) as it prospects on the nettle stem for a suitable site for making this pad; then, having woven the pad, as seen in the right-hand photograph above, it attaches itself to the pad and hangs head downwards (centre below, × about 2). The third picture (× about 3) shows it just before the splitting of the skin, which is shown in detail in the top left-hand picture in the oppo[illegible]**

Gaumont British

GETTING READY FOR THE GREATEST CHANGE OF ALL

Continuing the story from the opposite page, we see in the first (× about 6) of the three photographs above that the larval skin has begun to split, and the pupal case is showing through. This splitting takes place very rapidly, and when it is finished the larval skin, a shrivelled remnant, hangs at the top of the pupa (centre, × about 7), which is attached to the pad also shown in the upper right-hand picture in page 234. A few weeks pass and the chrysalis in turn splits and liberates the full-grown insect. In the third photograph (× about 4) an empty case is seen hanging from the nettle stem. After a few days' autumnal sunshine, the Small Tortoiseshells go into hibernation, a winter sleep during which they are inactive, or, if roused artificially, are capable only of weak, fluttering flight (left bottom picture). When the warm days of spring come, however, they awake, and the insects seen in the last picture are preparing to issue forth and greet the sunshine. (Lower pictures about life-size.)





J. J. Ward

VANESSID CATERPILLARS

The caterpillars of the Red Admiral butterfly, seen in the picture above, differ from those of other members of the Vanessid tribe in that they live not in companies but alone. Those seen here are fully grown and just about to pupate. On the right is the larva of the Large Tortoiseshell.

group. The latter may be described shortly as a very finely-coloured butterfly with extremely strong powers of flight ; as to its markings, it has a great deal of black towards the front of the fore-wings, with white spots, and reddish-pink as a general ground colour. The underside is remarkably beautiful, being pink, pearly brown, and white with a few black markings.

Exquisite Hues of the Peacock

NEXT to the Small Tortoiseshell the Peacock is the commonest insect of this group, as well as the most distinctive. Its name is descriptive, and no one, once seeing it, could possibly mistake it. The wings are of a fine reddish purple, with large white, blue and purple eye-spots at the fore corners of both front and hind wings. Inside the spot on the fore-wings there is a black patch ; inside that is a yellow wedge-shaped marking, within which is a second black patch. This, it will be seen, reproduces to a certain extent the marking along the front margin of the Tortoiseshells. The colouring of the underside of the Peacock butterfly is exquisite—a warm, purplish-brown, so dark in some insects as to appear quite black.

Although it hibernates, and is thus often found in the house during the winter months or at the time of spring cleaning, the Peacock is more an autumn than a spring insect. The caterpillars are found on nettle leaves, where they live for the greater part of their lives in companies, completely denuding the plants. They are black, and appear to be even more spiny than those of the Tortoiseshell, to which, however, they bear a marked family resemblance. The chrysalis, as may happen with that of other Vanessids, is frequently covered with dots of a brilliant metallic lustre ; the reason for this is not known, but it is presumably largely connected with the pigments resulting from the food of the insect.

QUITE as popular as the Peacock, and almost as common, is the Red Admiral butterfly, perhaps the handsomest of all our native insects. It is in no way connected with the sea, its name being in fact a corruption of "Red Admirable Butterfly," a label that was given to the insect by the old naturalists two hundred years ago. It is not strictly a Vanessid, belonging, in fact, to the same genus as the Painted Lady. The wings show the same square outline in the fore corners, but the rear wings have a more rounded contour with a scalloped edge. The fore-wings are brown on the inner area, but this gives place to a beautiful velvety blue-black towards the front and the outer margin ; a broad, broken band of bright scarlet runs diagonally across from the inner end of the fore margin, and outside it is a series of pure white spots, which comprise another band. Beyond them again are more small white spots. The rear wings are

blackish-brown, with a broad band of rather paler scarlet along the rear margin, containing four black dots. The female is slightly larger, as is usually the case among butterflies, and her rear band of scarlet is a trifle longer. The underside of the fore-wings shows the same features as the upper-surface, but the colours are far paler, the red band being partly whitish, while the ground colour is brownish with faint bluish markings ; the hind wings are uniformly mottled and brownish, with a pale spot on the front edges and a pale patch where the red band is above.

The caterpillar, which, like that of the Peacock, feeds on nettles, lives in a tent of the leaves, being solitary, in contradistinction to the sociable caterpillars of the true Vanessids. The tent is gradually eaten away until the occupant is exposed, the tent apparently being rendered useless for purposes of protection. The larva itself varies in colour from black to grey or brown, with spines of similarly varying colours.

Problem of the Red Admiral

THIS butterfly affords one of the most perplexing of the many problems that face entomologists, for in the same locality it is very common in some years and rare at other times ; the answer to the problem is now considered to be that migration from the Continent takes place. The English-bred specimens are probably those that are seen on the wing in the late summer and autumn, while the spring examples are immigrants. In the late summer an interesting habit of the Red Admiral may be observed ; this is its peculiar partiality for rotting fruit and even for animal carrion, on which it may often be seen feeding, a crowd of the fine insects collecting on the ground about a rotting apple and mixing there with the flies and wasps that have been attracted to the feast.

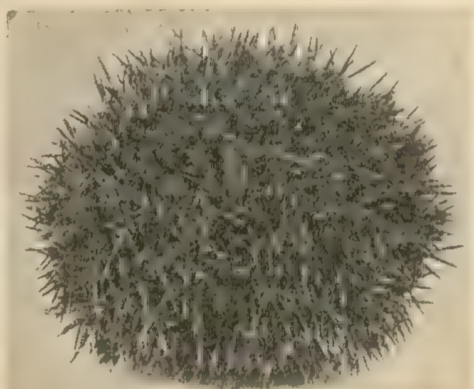
Our Wild Animals and Reptiles. 7

THE PRICKLY HEDGEHOG IN FACT AND FICTION

IN outward appearance and physical constitution one of the most curious of creatures, the hedgehog has been a denizen of Britain's countryside for, it is believed, many thousands of years. In this chapter we learn of its distinctive features, particularly of its spiny panoply, and something of the way in which it lives—and sleeps

THE climatic conditions of the temperate zone have made any large increase in the number of insectivorous animals impossible in Great Britain. Unlike the Rodentia, the Insectivora in this country are very few in number; they are limited, indeed, to a meagre series of five species—three shrew mice, the mole and the hedgehog. In many respects these insect-eating mammals are very like the Rodentia, both in habits of life and general physiological formation. The incisor teeth have not, however, the chisel-like shape of the rodents' incisors, and the molar teeth, instead of having grinding crowns, are developed into pointed spikes much more suited for the piercing of the chitinous armour with which all adult insects are covered. There are always five toes on each of the feet, and these have claws, the animal walking on the sole and not only on the ball of its foot. The naturalist's names for the three distinct families of Insectivora found in this country are *Erinaceidae* (hedgehogs), *Talpidae* (moles) and *Soricidae* (shrews).

The hedgehog is the largest of our five Insectivora, and here we may note that throughout the entire world insect-eating animals never grow to any great size. Undoubtedly the whole order would have been wiped out many thousands of years ago during the ruthless process of evolution, had not each species found for itself some special means of protection or of finding food. In the case of the hedgehog, or hedge urchin or hedge pig as it is variously styled, this protective device takes the shape of a coat of spines, which is the little animal's most original characteristic and one by which it may be, and is, universally recognized.



H. Bastin

It is perhaps best to explain the origin and general anatomy of the spines before we consider the various points of the hedgehog's life history and habits. The spines are really nothing more than enlarged hairs, the piths of which have expanded enormously to give them a solidity and elasticity of which hairs are not possessed in the ordinary course of events. The spines number about 270 to the square inch, and, if the whole animal is looked upon as a spine-covered sphere when rolled up, this works out at about 16,000 for an entire skin.

EACH quill is shaped like a spindle tapering at the end, and is bent almost at right angles just about where it enters the skin. It consists of an outer shell in an inner and somewhat harder pith. The shell is furrowed in lines throughout its length, while a cross section shows that the pith is ridged in such a way that each of the ridges protrudes into the spaces between the furrows in the shell. At the base the quill expands into a mushroom-like protuberance, which not only enables the muscles to get a better grip, but also makes it almost impossible to pull out the quill. A hedgehog can be easily picked up by a single quill and suffer no harm.

Mechanism of the Hedgehog's Armour

THE raising and lowering of this wonderful array of spikes is mainly effected by a muscle known as the *paniculus carnosus*; possessed by all mammals, in the hedgehog this is specially enlarged, extending over most of the animal's body, and making it, quite apart from its prickles, a very difficult specimen to skin. This muscle plays a great part in that physical achievement for which hedgehogs are so renowned. The animal can remain curled up in a ball for almost as long as it wishes, and, in fact, does so throughout the entire winter months during the period of hibernation. No other animal is capable of curling itself up in such a compact and safely guarded sphere. This carnosus muscle can also be found in Man, though by no means developed to such a high degree, and in some cases men and women are able to move their scalps and also their ears. It would seem that this ability decreases with age, for it is rarely found in old people, though fairly often in children. The muscles controlling the behaviour of the

ROLLED UP

At the approach of danger the hedgehog composes itself into a prickly ball (left), and it assumes a similar but less compact shape during hibernation (below).

B. Hanley

prickles on a hedgehog are exactly similar to those used in moving the human scalp. But although the action of the hedgehog in rolling itself into a ball is brought about principally by the carnosus muscle, the stresses and strains on the rest of the body are so highly complicated that one might almost say there are few muscles which do not come into play. If a hedgehog were to have all its quills removed and still remain alive, the carnosus muscle would look something like the thickened shell of a tortoise.

Quaint Stories About Hedgehogs

THERE are many country tales told of the cunning and generally strange behaviour of the hedgehog, but the majority of them are completely unfounded. Many old country farmers still believe that hedgehogs climb up apple-trees and, shaking down the apples, fall to the ground themselves, impaling the fruit upon their spines, so that when they go back to their nests they carry an apple with them. Like most of such stories, this one can immediately be discarded as untrue, since the hedgehog, being insectivorous, or at any rate wholly animal-eating, does not eat apples. The story probably originated with Pliny, from whom also comes the strange tale of hedgehogs sucking the milk from cows, so that when the milkmaid arrives in the morning with her pail, she finds her charges already milked. This tale also is, of course, untrue, since the hedgehog is by no means large enough to reach up to the udders of a cow, nor is any cow patient enough to lie down and wait for any animal to milk it—let alone a hedgehog, whose mouth is far too small in any case.

The adult male hedgehog usually measures approximately 9¼ inches from the head to the end of the body, while the tail is sometimes as much as an inch in length. The females are always slightly smaller than the males. The adult weighs about 1½ lb., and in relation to its size the neck and body are distinctly shorter than in any of the other British mammals. The eyes are bright and slightly protruding, and the legs are so short that the body little more than clears the ground.

When frightened, the hedgehog will first of all wrinkle up its face so that all the spines stick out and protect its eyes. It will then, by means of its special muscles, raise its spines ready for an attack, and, if things look really desperate, will immediately curl itself up into a ball and remain thus protected until the danger has passed. In this position it presents a defence which very few animals are able to overcome, though it has been said that the fox and also the badger are capable of pulling it to pieces in spite of its spiny armour. One of the few dogs which are said to be able to destroy a rolled-up hedgehog is the Alsatian wolfhound, which, by biting at the hedgehog's folded legs and then gnawing through the muscles of its stomach, forces it to unroll. Only animals that are very hungry will actually attack a hedgehog in cold blood, and if the young are available these are always eaten in preference. Although it is usually almost completely silent, it has been stated that when a hedgehog is caught by a badger it utters a pitiful wail, despite the fact that, according to one naturalist, "he will permit himself to be torn to pieces by a terrier without a cry."

GROWING THEIR ARMOUR

The closed eyes and white, wrinkled faces prove that this litter of hedgehogs is only a week or so old. Few spines have made their appearance as yet, and they are white and pliable instead of black and strong as in the adult.

H. Bastin

Boars and Sows and Their Babies

BECAUSE of the pig-like snout these animals were originally given the name of "hogs," and the male and female are known respectively as boar and sow. The males, although fighting a great deal among themselves, make quite domesticated spouses, and almost invariably mate for life. Some time in the middle of the summer, between June and August, the sparsely-clad and somewhat pale-looking baby hedgehogs are born, numbering from four to seven. They are blind and completely helpless. The nest, which is usually built inside a thick hedge or in any well-covered spot, is composed of dried leaves, grasses, and sometimes moss. Although the quills of the new-born hedgehog are white, soft and pliable, they soon harden and assume the black colour of those of the adult. About a month elapses before the young urchin is capable of rolling itself into a ball, and until then it does not venture outside the nest. Parents and their offspring sometimes stay together for as much as a year—a fact which has an obviously important bearing upon the successful way in which the hedgehog has held its own in a world abounding in dangers for the unwary youngster—and with the coming of autumn a roof is built on to the nest and the whole structure generally prepared for the period of winter slumber.

The hedgehog is a hibernating animal, and as soon as the weather gets cold the family retire into the nest and, curling up together, they all go to sleep. Since they never wake up or go out into the open throughout the entire winter, there is no need to make a winter store of food. Since, also, they are insect- and animal-eating animals, this would be almost impossible. Unless there is a spell of really very mild weather the hedgehog remains in a state of hibernation from the end of October until the coming of spring at the end of March.

Although they come under the heading Insectivora, hedgehogs will eat practically anything that is as "crunchable" as an insect. Slugs, snails, centipedes, earthworms—these are all favourite dishes for the hedgehog, and when the young have been suckled they go at once on to the same diet as their parents. Hedgehogs have even been known to kill rats and mice, and one distinguished naturalist tells of a young leveret being attacked by one of these animals. Lizards, snakes and, above all, eggs are also part of the menu, and their partiality for eggs gamekeepers make a pretext for killing off as many hedgehogs as they can. It is a lame excuse, for no one can fail to admit the damage done by insects on all estates, and the hedgehog undoubtedly plays a great part in keeping down the growth of these pests; and very seldom does a hedgehog find it possible to drive a pheasant from its nest and suck the eggs. Slow, lumbering animals that they are, hedgehogs are rarely capable of attacking anything beyond the most lowly insect, and the only way in which big game can be added to their menu is if it happens to be caught in a trap or harmed in some other manner.

Neville Kingston

SHARING A DRINK

Usually all that the camera succeeds in recording of a hedgehog subject is a ball of prickles. Above, however, is a much more revealing study, showing a boar (left) and sow partaking of liquid refreshment together. Other studies are given in page 244.

AMONG other interesting physiological attributes, the hedgehog possesses what are known as hibernating glands, as to whose nature and function physiologists are still uncertain. It has been observed that the glands become greatly enlarged just before the autumn and gradually decrease in size throughout the actual period of hibernation. Similar glands appear in all other hibernating animals, more especially in the shrew mice. It would seem that they are utilized for storing, besides food supplies, special anti-toxins which can cope with the invasion of bacteria that automatically takes place as soon as hibernation begins. A migration of enormous numbers of the phagocytes (anti-germ white corpuscles) at the beginning of hibernation towards those parts of the animal's body which are particularly open to attack from bacterial enemies, seems to support this theory.

The dentition of the hedgehog is:

$$i\,\frac{3}{2},\quad c\,\frac{1}{1},\quad pm\,\frac{3}{2},\quad m\,\frac{3}{3},\ = 36$$

Hedgehogs are found widely distributed throughout Europe and occur in all districts in England, in some parts of Ireland, and as far north as the middle of Scotland. They are also found in the Shetland Isles, but it has been suggested that they are not really native but have been introduced from the mainland.

HEDGEHOGS IN THE GARDEN

Although the lover of wild animals is not advised to keep them as pets, hedgehogs can make themselves extremely useful if introduced into the garden. Being insectivorous, they will prove invaluable in keeping down all forms of insect pests, and if shut up in the house for a day or two they will make short work of any cockroaches or ants.

The best way to entice a hedgehog into the garden is to catch it when young and feed it on lumps of raw meat, milk and large quantities of its more natural forms of food, such as beetles, grubs and worms. After a time the animal will grow used to the garden and will not stray away even though the artificial supplies of food may cease. It will then forage for itself among the garden beds, and thus prove an exceedingly helpful ally of the gardener.

One disadvantage of the hedgehog kept as a pet is that it tends to become verminous, but that can be overcome by catching it now and again, and dusting it over with a good vermin powder

If a pair of hedgehogs, male and female, are kept in the garden, it is quite possible that they may breed, though in order to make sure of this it is best not to handle them too much before the breeding season. Since hedgehogs usually mate for life, a pair introduced into a garden where there are plenty of insects for them to eat, will probably remain there for the rest of their lives, in the course of which several litters of young ones are likely to be born. If left sufficiently alone, the mother hedgehog will bring up her young just as she would in the wild state, but if too much notice is taken of the babies there is a danger of the mother devouring them. After the young ones are grown up and are able to care for themselves both the mother and the father hedgehog will do their best to drive them away from the garden in order to make room for the next litter.

Making Hedgehog Nests

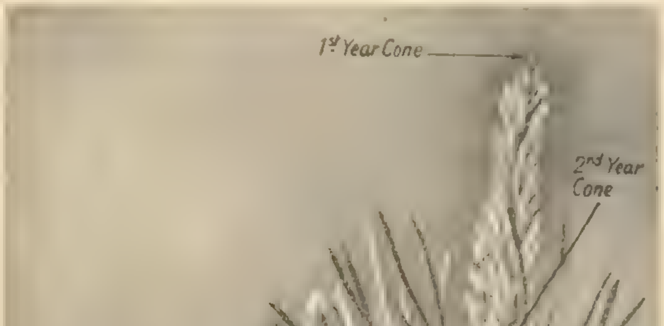
If the garden is not of sufficient size to provide natural sleeping quarters, artificial nests should be erected. Any shed, empty rabbit-hutch or large box will suit the hedgehog admirably, but a clean, dry and warm bed is essential, as well as a supply of fresh water and food when not actually sleeping.

As regards taming hedgehogs, it will be found at first that they have an annoying habit of curling up into a ball at the approach of any footsteps, but if handled often and quietly, they will acquire confidence, and allow one to tickle their smooth, woolly stomachs and even to smooth out their prickly backs.

BRITAIN'S ONE AND ONLY INDIGENOUS PINE

ESSENTIALLY a tree of the more northern and colder parts of the temperate zone, the pine comprises several species, but only one, the Scots pine—or Scotch fir, as it is sometimes (erroneously) called—the subject of this chapter in the "Trees" series, is included among Britain's native trees

No tree, in Europe at least, is so widely grown as the Scots pine, but it is a remarkable thing that many people are wholly incapable of calling it by its correct name. The versions Scotch fir and Scotch pine, both frequently used, are incorrect, and Scots pine alone is the proper title of this tree. There is much popular confusion regarding the words "pine" and "fir," and the majority of people are unaware that each has a special meaning, which should not be abused. The word "pine" is properly applicable only to members of the genus *Pinus*, but the word "fir" has a much broader significance, being used for the spruce fir, silver fir and Douglas fir, trees which belong to the genera *Picea*, *Abies* and *Pseudotsuga* respectively. It must be understood that the word "fir" should never be used for a member of the genus *Pinus*.



CONE DEVELOPMENT

The appearance of the cone in its first, second, and third years is seen on this pine branch. The tiny first-year cone, fertilized by the pollen from the male flowers, grows rapidly, and by the spring of its second year is, though still green, quite large. Another year sees it dry, brown and open, for it has shed its seeds to the winds and will itself soon fall to the ground.

Except for the juniper, which many would not honour with the name of "tree," the Scots pine and the yew are our only native conifers, and of these the yew has sometimes been disqualified on the grounds that it is not a true conifer at all, many botanists separating it and placing it in an order of its own, *Taxaceae*. Of these three, the pine is by far the best-known and most widely distributed, besides showing all the characteristic features of a conifer. The first Chapter of this series (page 21) gave an account of the larch, which differs from all other conifers in being deciduous, but otherwise is fairly typical of the whole order. In most of the conifers, however, the flowers are by no means as conspicuous as they are in the larch, and this applies to the Scots pine as well as the others.

While walking through the pine woods in May or early June, we often find everything covered with a fine yellow powder, and if there is no wind we may wonder where it comes from and what it is. If there is any wind, however, the phenomenon explains itself, for the slightest breeze brings a fresh shower of this pollen, as it really is, from every pine bough. Shed by the male flowers, it makes the air thick with its yellow dust, and drifts over everything in tiny clouds. On the edges of ponds and in little hollows we may find quite a mass of it, and if some is collected and taken home in a suitable receptacle it will well repay inspection under the lens.

Tufts of Yellow Pollen

THE grain of pollen is then seen to consist of two tiny spheres, connected in such a way as to act as wings, so that the grains can take full advantage of every breath of air to fly farther from their parent tree. The male flowers which produce these pollen grains are borne in catkins, each of which is but ¼ inch in length. A number of the catkins combine, however, into spikes, which are often gathered into bunches. The yellow pollen makes the catkins very conspicuous, and when they are on the trees almost every branch may appear to end in a yellow-brown tuft.

The female flowers are borne in little cones, which are greenish-purple and egg-shaped. They are usually found in bunches of two or three, and after fertilization grow to a length of two or more inches. These cones take about eighteen months to ripen, so that they are bright green and still fairly soft in their first winter. It is during this time, moreover, that the squirrels do their greatest damage, ripping open the cones to extract the seeds. Crossbills also do a certain amount of harm in the same way, and where they are abundant, or wherever a flock of the birds has settled during its winter visit, a litter of discarded cones at the base of the trees betrays their

presence. We can tell whether crossbill or squirrel has been responsible for the damage by the methods which have been adopted. The squirrel bites off the whole cone, and on the ground below we can find the yellow, torn stalk from which all signs of the fruit have been removed. The scales themselves also litter the ground, for the squirrel removes them completely from the cones. The crossbill, on the other hand, nips off the cone, carries it to a firm perch, and holds it down, while it twists back each scale to get at the seed beneath. The scales are not usually, however, ripped right off.

Inside the Pine Cones

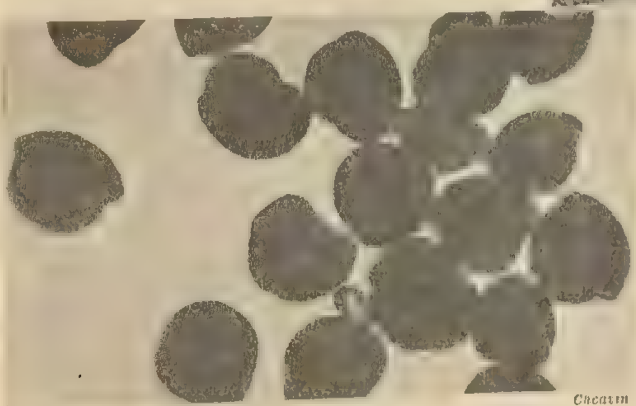
Each cone of the pine consists, as has been indicated, of a number of scales, each of which conceals a seed. These scales are roughly four-sided on the outside of the cone, and each one ends in a sharp little conical boss. When they are ripe the cones open out, the scales turning back in such a way as to expose the seeds, which then fall out. In dry, hot days of summer one can hear them opening and see the winged seeds dropping to the ground. These seeds are very much of the same type as those found in the ash, but their wings are more efficient and with even the gentlest breeze they may be carried to a great distance. This accounts for the pine's wide distribution.

In shape the typical Scots pine is unmistakable, and there should be no difficulty in distinguishing it from the other closely-related species that are sometimes found in a more or less wild state in this country. The trunk of the tree is typically straight, with short, stout branches, which start quite near the base. Unfortunately, most of the examples one sees have usually been denuded of their lower branches, either by Man or by the force of the winds and the weakening due to old age. These branches may, however, die off naturally, so that the mature tree is sometimes pyramidal in outline. Later the main shoot ceases to lengthen, but the upper branches grow on in such a way as to produce the flat-topped form that is characteristic of the fully-grown tree.

B. Hanley

ON THE BLASTED HEATH

In the hard, white light of the snowy winter's day the pines show up black against the sky, whose grey flatness emphasizes their bare, flat-topped form. Not long since a fire raged across the heath, for the lower branches of the trees are dead and the ground shows no sign of living thing.



Cncaum

DUST OF THE SCOTS PINE

In May the pine woods may be covered with a yellow carpet of powdery pollen, whose individual grains when magnified 320 times are seen as above. Each grain is equipped with flattened, wing-like projections, with whose aid it is enabled to make use of air currents and so travel far from the parent tree.

Few trees grow so quickly and with such regularity as the Scots pine, and when twenty years old it usually reaches a height of as much as forty or fifty feet. At its finest, it is well over a hundred feet high, but the round hundred is the average for a well-grown tree. A tree of that height has usually a girth of about twelve feet round the bole. The bark is dark and fairly deeply fissured on the lower parts of the tree, but higher up it is thin, flaking off easily, and is bright reddish in colour. It is this upper bark which gives the pines their wonderful reddish-purple glow so noticeable on a summer evening.

The needles or leaves which clothe the pine stay on the tree for two years. During the first year they are fairly bright bluish-green, or *glaucous*, but they soon become darker and harder. They are produced in pairs, a point which, with their length, about 1½ to 2 inches, serves to distinguish them from the needles of any other conifer.

H. F. Taylor

UPRIGHTS OF THE PINE WOOD

The bright glare of the summer sun illuminates the darkest pine wood, and, as in the present case, shows up to advantage the rugged aspect of the mustered boles. Longitudinal fissures and the stumps of small branches are as characteristic of the trunks as is the bracken undergrowth of the whole wood.

One of the features to which the pine owes its success is doubtless the efficient root system, which consists of a deep tap-root and a series of spreading roots not far below the surface of the soil. On shallow or otherwise unsuitable soils, however, the tap-root is not developed, and the tree is correspondingly less stable when subjected to the strain of a great gale. Like most trees, the pine also varies enormously if grown under exceptional conditions, such as on the side of a mountain, where the trunk becomes stunted and contorted, dwarfed and hardened, until one might almost think it was a completely different species of tree. The mountainside, then, does not normally produce the tall, gnarled, ragged tree trunk beloved of painters; that is found rather where one or two trees have been left when the rest of a wood has fallen or been cut. These trees, already tall and with few branches, now receive the full force of the gales, soon being bereft of their smaller branches and assuming a form well-calculated to delight the eye and warm the heart of the most romantic of wayfarers.

We find in the Scots pine the same unfortunate condition in regard to its timber as we noted in the larch, namely, that the timber produced by our native trees is by no means so good or so valuable as that of the great forests of the Scandinavian countries. The reason for this is that our climate and soil tend to produce a quicker-growing, coarser-grained, and correspondingly softer timber than that which has been subjected throughout its life to the more trying conditions that generally prevail in the more northerly lands.

Speedy Growth of the Scots Pine

In spite of this, the Scots pine is one of our most valuable timber trees, and it has, moreover, an added attraction, at any rate to the private individual who seeks to invest his capital in growing timber, in that it reaches maturity fairly quickly. A man may reasonably expect to reap the rewards of his own planting during his own lifetime, instead of knowing that it will be perhaps two generations or more before the fruits of his work are matured, as is the case when he plants oak and other hardwood trees.

Such a common tree as the pine is bound to have a certain fauna of its own, especially when it is chiefly grown in large plantations and what are known as "pure" forests, that is, forests confined to the one type of tree only. Their names alone are sufficient to betray many of the creatures that live on, in, or under the shelter of, the pines. Pine marten, pine bunting, pine hawk moth, pine beauty, pine carpet, and fir-rape are representatives of the mammals, birds, three families of moths, and flowering plants respectively, and there are many other species that are no less peculiar to the pine woods, although their names do not so readily reveal them.

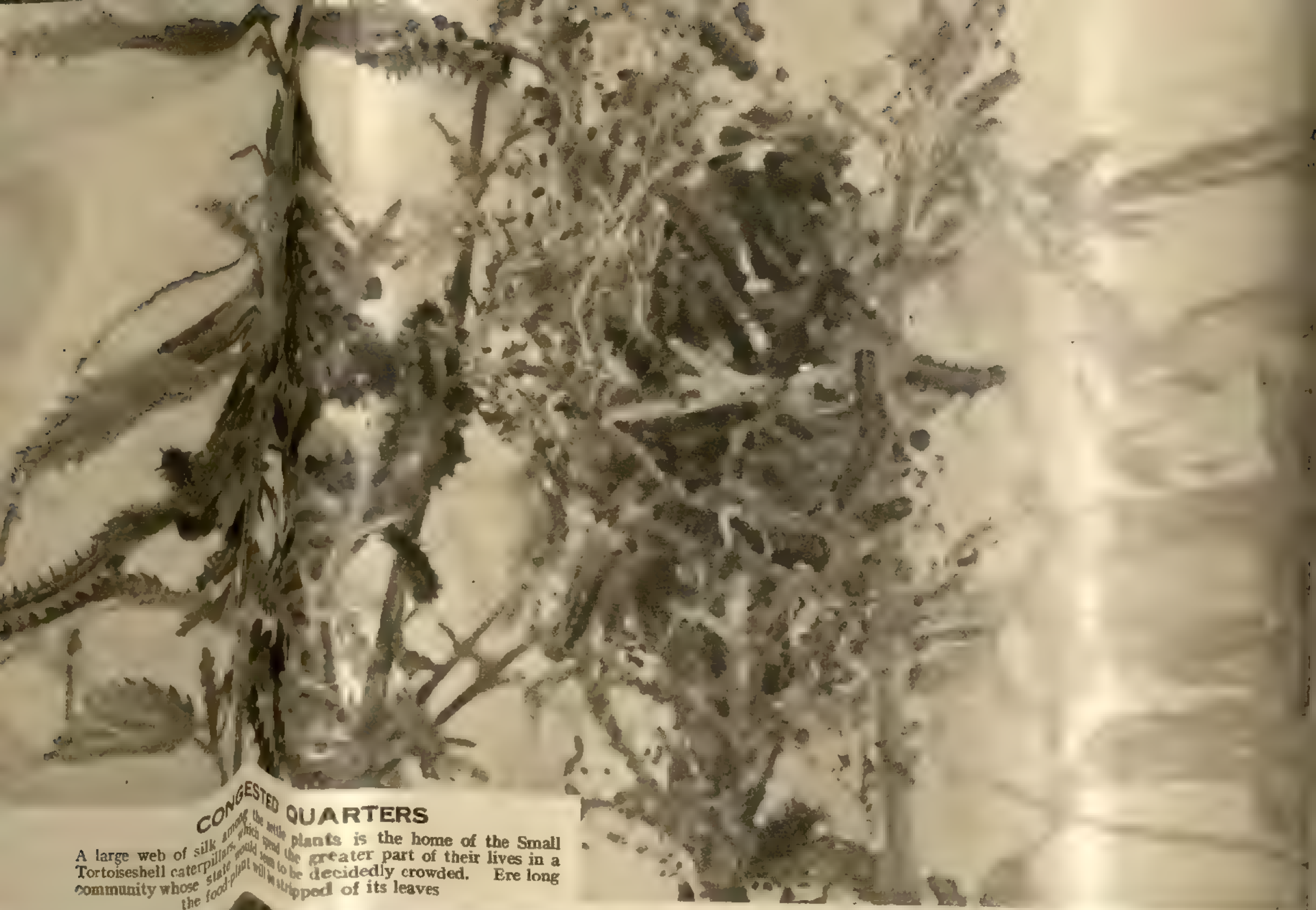
Among the birds, for instance, we have such scarce species as the crested tit and the crossbills, which are confined more or less to the pine woods. Then there are large numbers of moths, besides those already mentioned, such as, for instance, the bordered white. Wherever there are pine woods the bordered white may be seen, often in large numbers, from May to July, according as to whether it is in the north or the south of the country. The wings are brown, either dark or chestnut-coloured, with largish patches of pale yellow or white, or, in the chestnut-coloured specimens, dark yellow, on the fore and hind wings. The caterpillar is striped with light and dark green in such a way as to make it almost invisible when it is at rest or feeding on similarly-coloured needles of the tree. The adult moths have weak flight, and, since they fly in the daytime, easily attract attention and may be caught by the collector without much difficulty.

Among the beetles, the pine weevil does a great deal of damage, attacking injured trees and laying its eggs in the bark so that the young grubs soon riddle the trunk with holes. A number of species of bark beetles also infest sick or unhealthy trees, and the wood wasp (*Sirex*), the subject of a separate chapter under the heading of Wonders of Insect Life, is one of the worst enemies of the forester wherever pines are grown.

PINE-TREE KNOLL

Their flattened heads outlined against a sky filled with menacing clouds, and the ruddy bronze of their slender trunks unillumined by any rays of cheerful sunshine, this group of Scots pines rising from a grassy knoll makes a picture of sombre beauty

Dixon-Scott



CONGESTED QUARTERS

A large web of silk among the nettle plants is the home of the Small Tortoiseshell caterpillars, which spend the greater part of their lives in a community whose state would seem to be decidedly crowded. Ere long the food-plant will be stripped of its leaves

Gaumont-British

PLACES IN THE SUN

Sitting preening themselves on the ox-eye daisy flowers, Small Tortoiseshell butterflies show off their fine colouring to advantage, the flowers and the grass making an admirable background to their red, yellow and blue wings. A detailed study of these butterflies begins in page 232

Gaumont-British

FORAGING FOR FOOD

The hedgehog, whose characteristics and curious ways are described in pages 237-239, mainly subsists on an insectivorous diet. In the garden, indeed, it may prove a very useful addition to one's livestock, for it is an untiring searcher after insect pests

S. Crook

SUMMER SLUMBER

Although the hedgehog sleeps all the winter, it still requires plenty of sleep during the spring and summer, especially after a heavy meal of insects. When sleeping but not hibernating, it does not roll itself into a tight ball, but lies on the ground (as seen below) in a half-rolled condition

S. Crook

RAIN-STORM AT EVENING

Over the greater part of this landscape rain is falling steadily, and above the aeroplane the rolling masses of cumulus clouds mark the continuance of squally, stormy weather. This fine air-photograph was taken by Captain Buckham one summer evening when homeward bound

RAIN AS THE SCIENTIST SEES IT

OURS is a rainy climate, for Britain lies in the path of the south-west wind, heavily charged with moisture picked up during its Atlantic crossing, and the watery load is dropped when the wind encounters the hills and mountains opposing its passage. Below is an account of what may be described as the mechanics of rain—an aspect of the subject seldom presented to the reader

WITH springtime and the promise of summer in the air, the entire British population hopes every year for a finer summer than the last. By "fine" is meant that little or no rain should fall throughout the months from May to September; but ever since the date when meteorological officials began keeping records of the amount of rainfall in Britain, it has turned out that the summer has never really been as "fine" as people probably hoped. The British summer is, in fact, naturally and quite regularly, a fairly wet season, and if the rainfall should drop only a few inches below the average there is very shortly consternation throughout the country, as in the summer of 1934. We are not prepared for dry summers, and yet towards the end of spring we always hope for them. When they come we complain that there is not enough water about.

BUT what is this rain, and why do we find it falling upon us through the atmosphere? Where does it come from, and what are the conditions necessary for it to make an appearance? Meteorologists have carried out a great deal of research into the problem of rain formation and the origin of clouds in the sky. The whole basis of all meteorological science may be said to be the fact that when air is heated it expands and is, therefore, forced upwards by the surrounding air of greater density. A column of air rising upwards from the surface of the ground is not only released from the heating effect of the "dull" reflected rays of the sun, but it is also cooled, because it expands rapidly as it rises—this last phenomenon being known as "dynamical" or "adiabatic" cooling.

If the valve is removed from the inflated pneumatic tire of a motor-car, the metal fitting through which the escaping air rushes soon becomes very cold, owing to the rapid expansion of the gases released from pressure. The scientist looks upon a gas as being made up of a very large number of rapidly-moving, extremely minute spheres, called "molecules." The higher the temperature of the gas, the more rapid the movement of these spheres and, therefore, the greater the pressure that they exert on any vessel containing them. Conversely, if the vessel containing them is enlarged and the pressure thus decreased, the spheres will move more slowly—in other words, there will be fewer collisions—and the temperature will fall.

WHERE MOST RAIN FALLS
As this map shows, the wettest districts in the British Isles are situated in the comparatively hilly and mountainous west.

The dynamical cooling of air as it rises from the surface of the ground accounts for a lowering of temperature by about 1.6 degrees Fahrenheit for every 300 ft. of ascent. But a second factor, known as the normal temperature gradient, brought about by the distance from the surface of the earth and, therefore, the lessened intensity of the sun's reflected rays, causes the air to cool approximately by 1 degree Fahrenheit for every 300 ft. of ascent. If, then, we consider a volume of air rising, its temperature will fall at the rate of 1.6 degrees Fahrenheit for every 300 ft., whilst the temperature of the surrounding air will change only by the amount of the normal temperature gradient, that is, 1 degree Fahrenheit every 300 ft. Thus the rising air is falling in temperature at the absolute rate of 0.6 degrees Fahrenheit for every 300 ft. compared with the air around it.

When a gas such as air is mixed with water vapour the water will remain in the form of a gas only as long as the temperature is sufficiently high. If the temperature is lowered the water vapour will condense into liquid water and eventually be deposited on any solid thing that may be near at hand. The rain which falls from the sky is made up of numerous drops of water, each of which has been deposited round a central nucleus composed either of a tiny smut or of a still finer drop of water. In time, hot air rising from the surface of the earth, owing to natural cooling which takes place, will be forced to give up the water vapour which it carries with it. This will take place before the temperature of the rising air becomes equal to that of the air surrounding it. It sometimes happens in open spaces where there is little dust that, although the temperature of the air is lowered sufficiently for the water to condense, there are no natural nuclei around which raindrops can be formed, and the temperature has to be lowered much further before rain will fall. Such a state is known as "supersaturation," and a small drop in supersaturated air is said to be in a state of "unstable equilibrium."

A rising column of air usually produces the centre of a cyclonic system, and the winds blowing in towards the centre in an anti-clockwise direction (in the northern hemisphere) tend to fill up the space left by the air and restore equilibrium. The condensation of the water vapour carried upwards in the column of rising air gives

S¹

AFTER THE STORM

Rainfall is expressed as the number of "inches of rain" that have fallen on one square inch in a given time. The figure is ascertained by measuring the amount of rain collected in a basin of considerable area and then arriving at the final figure by a process of reduction.

rise to the formation of masses of water-enshrouded nuclei, which are nothing more than "highly elevated layers of mist," or clouds. The drops of water formed at first are very small indeed, probably not more than .002 mm. in diameter, and, having very little weight, continue to be carried upwards by the rising air. Further ascent, however, means continued cooling and more condensation of water upon the drops, their size thus increasing still more. When the diameter reaches 0.2 mm. the weight of the drops becomes sufficient for them to start falling relatively to the air, at the rate of about 1 metre per second. A normal air current rising directly upward does not flow at anything like this pace, so that at this stage clouds actually begin to precipitate rain.

In a vacuum, of course, everything would fall with the same rate of constant acceleration of 32 ft. per second, per second. In the presence of gas, or a mixture of gases, such as the air, however, this is not the case, for the gases form a resisting medium and the velocity of the falling body does not increase by exactly the same amount when this force of resistance is taken into account. The velocity, therefore, of the raindrop does not increase throughout the entire length of its fall, for there comes a time when the resistance of the air is exactly equal to the weight of the falling drop, and the latter thenceforward falls at a constant speed. This speed, even now, is not uniform, but becomes less and less as the pressure grows greater and greater in the lower layers near the ground surface.

Velocity of the Raindrop

The rate at which a raindrop falls depends, naturally, upon its size, but scientists have found a name for the steady speed which it ultimately attains, and this is known as the "terminal velocity." There is a certain amount of friction set up between the drop and the atmosphere through which it is passing, and this is also taken into account when the terminal velocity for any given raindrop is worked out. One of the most important facts is that the terminal velocities of raindrops do not increase indefinitely with their size, for when the drops have a certain diameter the terminal velocity remains practically constant at 8 metres per second, or 17.9 miles per hour. The reason for this is that the drops, owing to the pressure of the atmosphere, become deformed in shape, or flattened out horizontally, so that their air resistance is increased very considerably. If the diameter of a drop becomes greater than 5.5 mm. this flattening out occurs to such an extent that the drop eventually breaks up before the terminal velocity of 8 metres per second is reached. What follows from this is the fact—which is of particular importance to the meteorologist—that no rain can fall through a current of air which is ascending faster than 8 metres per second.

Few people caught in a sudden April shower would ever stop to think of all these facts and figures; caught without a raincoat on an open moor, or without an umbrella in the street, it matters little to the hurrying refugee at what speed the raindrops are falling or from what height they have come. But to the meteorologist such details are necessarily of the highest importance.

CONTINUAL RAIN

Here we see, open for inspection, a smaller type of rain-gauge than that shown in the upper photograph. The rain enters through the small tube seen emerging above the barograph which forms part of the compact little instrument.

Negretti & Zambra

SKATES AND RAYS–FISH OF ANCIENT LINEAGE

In an earlier chapter (page 190) it is explained that fish are divided into two classes—bony and cartilaginous—and the plaice is taken as a typical representative of the former class. Now in the chapter below we learn of two typical cartilaginous fishes—the skate and the ray. Both are flat-fish, and are so primitive in shape and structure that they closely resemble ancient fish whose fossilized forms are found in the rocks

THERE is a group of fishes of flattened shape, the skates and the rays, which are not pleuronectids and, indeed, bear no relationship to the plaice and the sole. They are flattened between the back and under surface, or in the *dorso-ventral line*, instead of being compressed in a sideways direction, or laterally, and so there is no twisting of the eyes and jaws. Apart from this obvious difference between the two groups there is a much sharper division between them, for the skates and rays have cartilaginous instead of bony skeletons and so are nearly allied to the sharks and dogfish, together with which they are classified as the *Elasmobranchii* (Gr. *elasmos*, metal plate; *branchia*, gills). The Elasmobranchii are some of the oldest types of fish in existence today, their prototypes being found in some of the ancient rocks of the Palaeozoic era.

All the skates and rays are bottom feeders, but since they prey mainly on small fish they lead an active life in search of their food and are more agile than the majority of the pleuronectids. Their method of progression is interesting, for they move through the water in a series of undulations in which both body and fins take part, their flexibility being largely due to their cartilaginous skeleton and lack of solid bone. The sight of a skate swimming is a remarkable one, the leisurely certainty of its movements being in strong contrast to the hurried, jerky progression of the pleuronectids or true flat-fish.

Some Facts About the Skate

NEARLY every visitor to the seaside knows the skate by sight—its flattened shape, long tail, and greyish mottled back. On the top of its head are placed the two eyes and its bluish-white under surface is slit by a gaping mouth. In addition, the skates possess an extra respiratory organ on the top of the head behind the eye, known as the *spiracle*, which is in the nature of an additional gill situated by the spiracular cleft. This spiracle is an aid to breathing when the fish lies on the sea bottom with its gill openings covered, and the presence of a spiracle is peculiar to the skates, this organ being absent in the dogfish and sharks. The common skate can usually be seen when the hauls of fishing boats are examined, for it occurs commonly in British seas, being taken from waters of varying depth, though it is found most often inshore. Though not generally recognized for its quality, the young skate is quite palatable, though the bigger and older fish are too tough to be enjoyed.

The classification of the skates and rays has been much debated, but twelve species are found in British waters besides the sting rays and the electric rays. These last, though of comparatively rare occurrence, are important from the viewpoint of the visitor to the seaside on account of the unpleasant surprise they can give the unwary, and great care should be taken to avoid contact with either of these fish.

The electric rays are found in all the British seas, one form, in particular, being plentiful in the Irish Sea, whence specimens are taken annually. The electric organs are paired and are situated in the head on either side of the spinal cord, and by means of them the fish is capable of giving a sharp shock when touched, though some people seem immune to the effects of these living "batteries" of the seas. Luckily the electric ray, or torpedo, as it is also called, is easy to recognize on account of its being shaped differently from any of the other skates and rays. The torpedo has a disk-like shape and a much broader tail than is found in its other and harmless relatives. The sting rays, like the electric rays, are more common in tropic than in temperate seas,

GRACEFUL MOTION

In this picture of a skate swimming we see how the great lateral development of this fish, combined with its flexibility due to the cartilage of which its internal skeleton is made, aid it in its progress through the water. The motion is analysed stage by stage in the left-hand illustration overleaf

Neville Kingston

SWIMMING BY STAGES

These eight drawings show the method in which the skate uses its lateral portions in the process of swimming. Note how the movement is initiated in the posterior portion of the pectoral fin and body, and is continued in a forward direction.

but they are found off the southern coasts of Great Britain in the autumn. The sting ray has also a somewhat disk-like shape, though it has a more pointed snout, but its tail is long and whip-like, and is armed with a sharp barb. This barb is a dangerous weapon, for, when captured, the ray lashes about with its tail with tremendous fury and can inflict a nasty wound, which may prove the more unpleasant on account of a poisonous mucus extruded by the skate which will cause the wound to fester and suppurate. Both of these two noxious fish are peculiar in being viviparous, that is, they bring forth their young alive, whereas most fish lay eggs. In this respect the electric and sting rays resemble the sharks. The common skates and rays lay eggs, the baby fish undergoing the latter part of its embryonic development inside a horny egg-case. These egg-cases are often cast up on our shores and are known in popular parlance as "mermaid's purses."

The development of the baby skate takes place within the horny egg-case, and the embryo receives the necessary oxygen either through *osmosis*, *i.e.* the sea water containing the oxygen penetrating and coming into contact with the inside, or else through the sea water penetrating to the inside by means of the holes in the four horns of the egg-case. Between the two longer horns there is a slit, and it is through this slit that the embryo escapes from the confinement of the case. When the baby skate emerges it is able to swim and to feed for itself, having no yolk-sac to rely upon as have many of the bony fishes.

Relationship of Skate and Dogfish

THE young skate shows very clearly its affinities with the dogfish, since in its early stages it closely resembles the young dogfish and does not immediately appear in flattened form. Gradually, however, the change takes place, and the young skate is seen to assume a more and more flattened shape as it approaches maturity. This post-embryonic development supports implicitly all the details of relationship between the dogfish and the skate which have already been deduced from an examination of their respective anatomies. This is one more example of the way in which a scientific classification of animals has been

SKATE PORTRAIT

When viewed from beneath, the skate appears to be perpetually grinning. Though the wide, gaping slit is the creature's mouth, the two holes above it are not the eyes—for these are situated on the other side of its body—but olfactory organs. Below the mouth can be seen the first two pairs of gill-slits

Neville Kingston

supported by the larval, embryonic, or early post-embryonic development of those animals. The importance of the changes that occur in the embryo has long been realized, so that it has given rise to the phrase, "*ontogony* repeats *phylogony*," *i.e.* that the embryo, in its development, passes through all the stages of the history of the race.

For the sake of convenience the ordinary skates and rays may be divided into those with long snouts and those with short snouts. In the first category are included the common skate, the white skate, the long-nosed skate, the shagreen ray and the flapper skate; while amongst the short-snouted varieties are included the thornback ray, the starry ray, the spotted ray, the painted ray, the cuckoo ray and the undulate ray. Of these rays, the thornback ray and the spotted ray are the commonest found off the shores of the British Isles, though all the species mentioned are caught in our seas.


Neville Kingston

LEOPARD OF THE SEA

This photograph shows the spotted ray moving upwards through the water. This member of the ray family is also known as the leopard ray on account of the mottled appearance of its dorsal surface; it is one of the commoner of our British rays and may be found quite often in fishermen's catches.

THERE is one more fish belonging to the elasmobranchs which is of particular interest since it serves as a connecting link between the skates and rays and the dogfish and sharks. This fish, which is known as the monk-fish, is the sole representative in British waters of its family. It has a very definitely flattened shape, though it has not developed the full flattened form, and while there is a considerable development of the pectoral fins, they do not join on to the head in the way characteristic of the skates and rays. There are two dorsal fins in the monk-fish, both spineless and situated on the tail. The colour is a mottled greyish-brown.

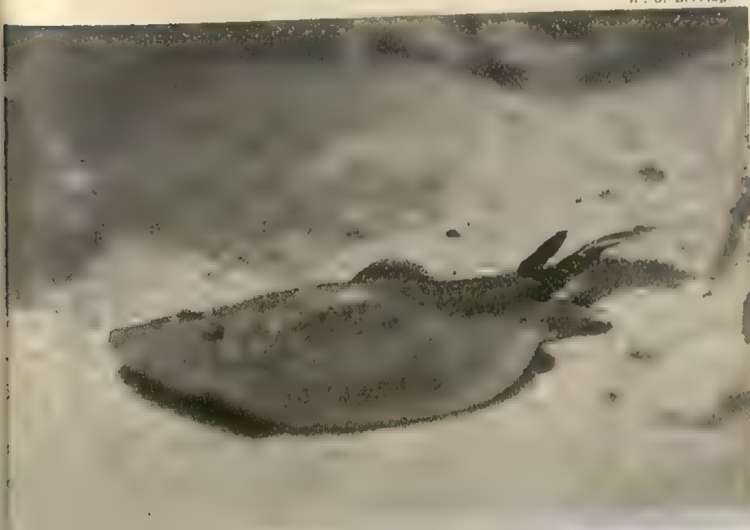
The monk-fish has been given its name on account of its shape and the pattern on its back, which combine to give it the appearance of a cowled figure when viewed from above. It has also been given the names of fiddle-fish, on account of its shape, and also angel fish, though there is nothing in its appearance to warrant the last name.

The distribution of the monk-fish is widespread, since it is found on all our coasts, living in deep water and

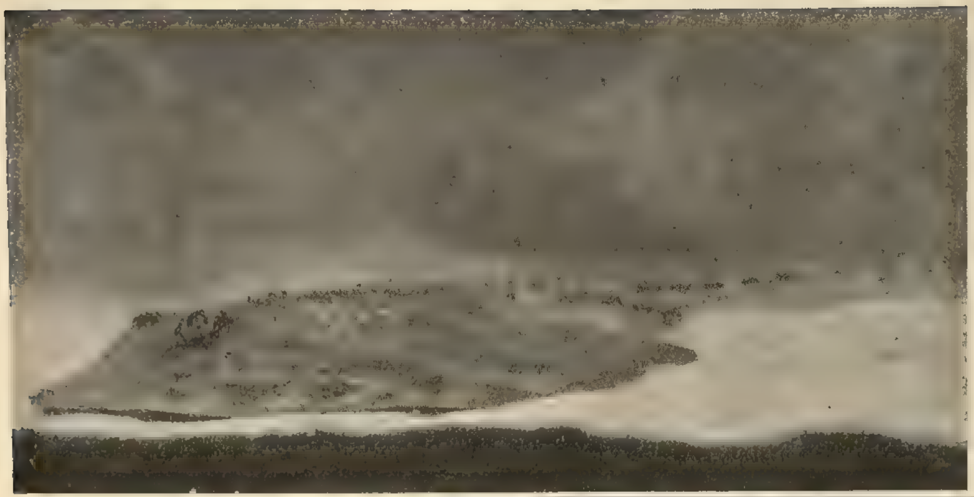
RAYS TO AVOID

In the photographs below are seen (left) the electric or torpedo ray; it is recognizable by its characteristic oval shape; (right) the sting ray, showing the long barb on the tail which is capable of inflicting a poisonous wound. Note the fin in motion.

W. S. Berridge



A. H. Jacob

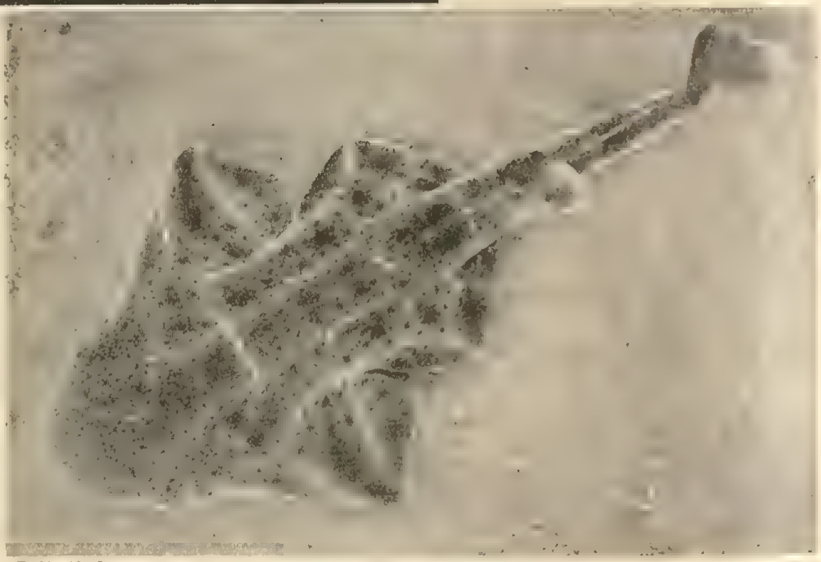


Berridge

RESTING THORNBACK

Another of our common British rays is the thornback, so called from the number of little spines situated along its back and tail. Though not noxious like the sting and torpedo rays, it must nevertheless be handled carefully.

should be taken not to strike too soon when fishing for skate, as the fish falls on its prey before turning and seizing it between its jaws; consequently the fisherman must give the skate time to swallow the bait before he checks the line. The skate is a difficult fish to play, as the width and development of its body give it great power in proportion to its size and weight. Sometimes the fish will lie motionless upon the bottom, and then the angler must wait patiently without attempting to play it until it chooses to move once more. These fish give the greatest sport when taken on rod and line with fairly light tackle, but for those who are in search of bigger game there are the large-sized skates of the Cornish and Irish coasts. These great fish may grow to a width of seven feet across, but special tackle should be used for them, and those who intend to fish for them would be well advised to seek expert advice.



F. Martin Duncan

IN MONKISH GUISE

The monk-fish (seen above) forms a connecting link between the skates and rays and the other elasmobranchs, having a semi-flattened form. It has been awarded its rather peculiar name on account of the markings on its back, which give it some resemblance to a cowled figure.

moving inshore in spring in order to spawn. The monk-fish resembles the sting rays, electric rays and sharks in that it is viviparous, producing about a score of small fish at birth.

Although relatively common, the monk-fish is very little known to the majority of visitors to the seaside, but it is worth while examining fishermen's hauls in order to see if one of these strange-looking fish has been caught; it may range up to two or three feet in length, and even larger specimens have been recorded.

This group or series of groups of the elasmobranchs thus surveyed shows how one minor division or class in the animal kingdom may contain a wide diversity of form, and variation of both habit and appearance; semi-flattened to flattened shape, viviparous and egg-laying habits, poison-barbs and electric organs, wide varieties of feeding habits and swimming capabilities are all shown among these cousins of the dogfish, most of which are commonly known to men as "skate."

Skate may be caught on all our coasts. As they feed on the sea floor a bottom tackle must be used, the bait most usually being some small fish such as a pilchard. Care

HINTS ON SKATE FISHING

Skate fishing with rod and line is quite an enjoyable sport and one that may be practised by anyone who is on holiday at the seaside. Skate may be caught off all our coasts, and range in size from small fish that have just hatched from the egg to monsters measuring seven and a half feet across and weighing some 200 pounds. The large specimens are not, of course, suitable fish for the novice. Much time, expense, skill and expensive tackle are required before they can be landed, and even then the sport that they give is not in proportion to the trouble taken.

The smaller skate, however, are not hard to find or difficult to catch, and though it is seldom worth while setting out with the intention of fishing for skate alone, skate are often captured when bottom-fishing methods are employed, i.e. when the hook and bait are weighted so that they sink down to the bottom. This method of fishing is a peaceful one, since one may lie back and rest while the boat rocks at anchor. Almost any bait will lure a skate, since it feeds off a varied diet, including various small fish and shellfish; but off Cornwall, particularly, a pilchard is very effective, especially when fishing on a sandy bottom.

Skate's Resisting Powers

The skate when hooked seems to the angler to be much heavier than is actually the case, since the great lateral development of the body and pectoral fins give it a power of resistance to the water out of all proportion to its weight.

The season for catching these fish is a long one, beginning in the early summer and lasting throughout the autumn and winter, so that most people who spend a part of their holiday at the sea have some chance of catching skate

Though not regarded as one of our most important food fishes, the skate does not make unpleasant eating, and to the enthusiastic angler the taste of fried skate will be exquisite if the pleasure of eating it is enhanced by the knowledge that it has been the result of his own fishing. When caught, all the skates and rays should be handled carefully, for though the sting ray and electric rays are the two most noxious varieties, all rays have rough skins, sharp teeth and spines, and should be dispatched by a blow on the snout as soon as landed.

FAVOURITE BLOOMS OF THE WATER MEADOWS

In this chapter we make the acquaintance of a number of delightful little flowers, all of which share a decided preference for the banks of river and stream and for the well watered meadows adjacent. Cuckoo-flower or lady's smock, marsh marigold or kingcup, greater and lesser spearworts, marsh cinquefoil, and the common and marsh louseworts—each and all may be distinguished in the course of a ramble in the later spring

In no situation do so many of our popular wild flowers grow as in the lush meadows that lead down to the banks of rivers and streams. Such welcome favourites as the cuckoo-flower and marsh marigold gladden our eyes as we wander along the streamside, but along with them flourishes a much larger and more various flora that we may fail to notice, although its members are no less interesting or beautiful than the more obvious plants. The present chapter not only describes the favourites mentioned above, but also gives an account of some of the other flowers that go to make the meadows lovely in spring and in the days of early summer.

M. H. Crawford

One of the best-known of all our flowers, the dainty cuckoo-flower or lady's smock, is, surprisingly enough, a member of the great cabbage family, better known perhaps as the natural order *Cruciferae* (Lat. *crux*, cross; *ferre*, to bear), so called from the fact that the various parts of the flowers are arranged in the form of a cross. In the *Cruciferae* the petals are always four in number, as also are the sepals, and there are six stamens, of which two are rather shorter than the other four. A further feature of interest is that the fruit of the cruciferous flower is usually a pod of the type known as a *siliqua* (Latin for pod), in which there are two long chambers divided from each other by a thin, flat central partition. Where the fruit is a short, flat type of pod, similarly divided, it is called a *silicle* (from Lat. *silicula*, diminutive of *siliqua*). In the cuckoo-flower the fruit is an ordinary siliqua.

The flowers of the lady's smock stud the fields with their delicate mauve masses, and no one who has ever lived in the country can have been quite unaware of their charm. The plant often may be as much as 18 inches high when in full bloom, and is of a delicate build that well matches the flowers themselves. The stem-leaves are of the type known as pinnate, and are rather small and dainty; but if we pull up a plant, or part the herbage at its base, and examine the radical leaves, we see that these are of quite a different shape, and form a very firm, round rosette, which protects the plant by preventing the growth of any other plants within a distance of a few inches from its base. The radical leaves are also pinnate, but are longer and stouter than the stem-leaves, and the small leaflets are rounded, instead of being long and narrow. The flowers themselves exhibit all the features of the typical cruciferous flower described above. They are slightly more than half an inch across, and the six stamens are bright yellow in contrast to the petals.

Vying with the cuckoo-flower for the position of favourite flower of the water meadows, the marsh marigold is as different, both in appearance and manner of growth, as one could well imagine, and it is perhaps for this reason that the two flowers, acting each as a foil to the other,

FLORAL SMOCKS

The cuckoo-flower (seen below; flower details on left) blooms in April and May, when "the Cuckowe doth begin to sing her pleasant notes without stammering." Its other name—lady's smock—is derived from its supposed likeness to little smocks hung out to dry.

H Bastin

H. Bastin

GOLDEN KINGCUPS

Strong, hollow stems and rounded, shining leaves form the background for the great golden saucers that are the cups—kingcups—of the country children. Known to the botanist as the marsh marigold, this flower is little more than a giant buttercup, finding its happiest home in the marshy water meadows.

are such popular subjects for the bouquets of country children. There could be no more striking contrast than between the dainty, mauve flowers of the lady's smock, on their slim stems, and the golden masses of the marigolds, with their huge leaves and thick, straight stalks.

Kingcups of the Meadows

ONLY a glance is needed to tell us that the marsh marigold is a relative of the common buttercups of the fields, for its flowers have the same fine golden colour and the same hard shiny texture which have earned the buttercup its name. To botanists the flowers are especially interesting because they have no petals, but only five or more rather rounded sepals, which are green on their outer surfaces, at least when the plant is in bud. In the midst of the cup (about an inch and a half wide) formed by these sepals there is a great mass of stamens; these hide the numerous carpels which are the centre of the whole flower. The likeness of the flower to a cup is recorded in the country children's favourite name for the marigold, "kingcup." The leaves of the marigold are rather heart-shaped, with rounded ends and a wavy margin, and they grow, as do the flowers, on stout stalks, which are of the same strong green colour as the rest of the plant.

Two other members of the buttercup tribe belonging to the same genus as the common buttercups described in Chapter II (page 336) are also among the characteristic plants of the water meadows. These are the greater and lesser spearworts. They both appear rather later than do the other members of the genus, being seldom in full bloom until June. They derive their name from the leaves, which are simple, long, narrow and sessile, and typically of the shape of a spearhead. The flowers of the spearworts are of the familiar buttercup type, varying only in size. In the greater spearwort they are an inch and a quarter in width, while in the smaller plant they are not much more than half an inch across. The stems are stiff and erect, and in the lesser spearwort there is a creeping rootstock; in this plant, too, the leaves may occasionally have a very short stalk, and they may be slightly hairy.

BOTH plants are found in the wetter parts of the meadows, and are at their best when growing actually in water, say, in a stagnant ditch or pond in poorly-drained country. In such situations the greater spearwort may be the most noticeable of all the flora, for its stems often rise to a height of as much as four feet, and it stands, so to speak, head and shoulders above the surrounding vegetation,

H. Bastin

STARS OF THE RIVERSIDE

The spearworts, greater and lesser, are easily recognizable as buttercups that prefer a semi-aquatic habitat. The greater spearwort, shown above, is distinguished from its fellow by its broader leaves, stronger growth and considerably larger flowers, but in other respects the two are very similar.

even when that consists of the lush grasses of the meadows or the rushes of the pondside.

A notably characteristic plant of the meadows, and one that, though somewhat less common than those so far described,, is also very widely distributed, is the marsh cinquefoil. Although it is no relative of the other species of cinquefoil found in this country, it owes its name to the same feature, namely, the division of the leaves into five segments. It is a plant that the rambler may not at once notice, since, in spite of its rather stout growth, it bears flowers that are not particularly conspicuous.

Peculiarities of the Marsh Cinquefoil

OFTEN known more specifically as the purple marsh cinquefoil, it has curious flowers of a dull, brownish-purple, the five petals being small and insignificant. There are ten sepals, rather pointed and narrow, and coloured in such a way that they attract more attention than do the petals. The stamens are extremely numerous, in this being reminiscent of those of the wild rose, and the plant is, in fact, a member of the rose family. The fruits, which are of the same colour as the flowers, are not unlike small, hard strawberries, and they persist, borne on the tough stems, long after the rest of the plant has died away. It is the presence of the leaves which often first attracts attention to the plant, for these are far more conspicuous than the flowers. Greyish-green above, and of a silky grey colour beneath, they have from five to seven serrated leaflets. The rootstock is large, strong and woody. If one is lucky enough to have an opportunity for an array of marsh plants in the garden, the marsh cinquefoil is one of the most attractive plants to transfer from the wild to a state of semi-cultivation.

H. Bastin

COUSIN OF THE STRAWBERRY

Curious as are the flowers (shown in the other photograph in this page) of the marsh cinquefoil, its fruits are even more remarkable, for they are like small, tough, purple strawberries, held within the five-lobed calyx. The plant is, in fact, a near relative of the strawberries.

A. W. Dennis

BEAUTY IN SYMMETRY

Marsh cinquefoil is the name of this denizen of the marshy meadows. In this specimen the leaves are divided into seven, not five, leaflets; and their symmetry, and that of the curious, dull purple flowers, lend an unusual beauty to what would, perhaps, otherwise seem a dull and insignificant plant.

Unassuming Red Rattle

EVERY type of plant is represented in the water meadows during spring and early summer, and by searching lower down, among the roots of the grasses and the taller plants that have already been described, we may come across some most interesting species. An example of such a plant is the common or field lousewort, or, to give it its more pleasant and more descriptive name, red rattle. This is a representative—the first to be dealt with so far—of the important natural order *Scrophulariaceae*, an order many of whose members are common flowers in every type of situation.

One of the salient features of many members of the *Scrophulariaceae* is that the corolla of the flowers is almost always extremely irregular, often being markedly two-lipped in a manner very similar to that which is also found in the order *Labiatae* (*see* Chapter 10, page 297). The red rattle is a flower that shows this feature. Its small, pinkish-purple flowers are almost exactly like

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calyx of the typical plant of this order is that it is persistent—that is, it does not fall off when the petals do—but is often to be found, many months later, a dry and withered object borne on a dead, brown stem. The leaves of all the species of lousewort are compound, and so much cut up into leaflets that they have a curiously feathery appearance.

How the Lousewort Got Its Name

THE common lousewort is not to be found in all water meadows, for its presence is a sign of a poor, badly drained, or otherwise ill-kept pasture. It is to this fact that it owes its name of lousewort, a name that is in itself a curious instance of what might be called libels on plants. The old-time herbalists gave the plant this name because sheep feeding in pastures where it abounded were often found to be verminous, a state they attributed to the fact that the animals had eaten the plant. Actually

M. H. Crawford

THE TWO RED RATTLES

The marsh lousewort seen in the above photograph is a more conspicuous but much less common plant than its lowly relative, the common or field lousewort, seen on the right. The curious nature of the flowers is clearly shown in the second photograph, while in both pictures a noticeable feature is the enlarged calyx, which long outlasts the flowers.

those of the white dead nettle, except for their colour, and the arrangement of the two lips is exactly similar. The chief difference is that in the red rattle the corolla tube is extended some way from the mouth of the calyx before it splits to form the two lips, so that it seems as if it may fall out of the calyx at any moment. The calyx itself also shows some of the peculiar features characteristic of the order for it is itself tubular, and composed of five lobes, of which several are usually ragged and slightly feathery, almost leaf-like in form. A feature of the

the pasture that nourishes lousewort is so poor that animals feeding on it are weakened and liable to become verminous. A similar plant, the marsh lousewort, which has duller purple flowers with purple calyx, though less common, is oftener found in the water meadows, where its more upright growth and generally stouter appearance make it easily distinguishable from its humbler cousin.

KEEPING A NOTEBOOK

For those who prefer to collect mentally, rather than to pick and preserve specimens of every flower, the notebook is, of course, a *sine qua non*. Not only is it necessary as a means of making certain of every plant that one may claim to have found, but it is of inestimable value when compared, for instance, with a notebook kept simultaneously by some other observer in another part of the country. Finally, there is the joy that can be had from looking through one's old notebooks and so having recalled to mind the many delightful days that were spent while they were being compiled—days spent, perhaps, in meadows that have long since become part of the town, or on cliffs that have collapsed into the sea.

Such a notebook may be arranged in various ways. For instance, the collector may choose to set it out in the same manner as the Flora or handbook which he uses, so that the plants all come in their proper classification. A certain space is allotted to each order and then to each plant within the order, and notes are made direct under the headings of the plants that they concern.

Scientific Classification

This, of course, precludes any general notes and is, indeed, a method for the pure botanist and the systematist who is more concerned with working out the various features of the flowers than with the places and times when they were found.

Then there is what might well be called the ecological notebook, in which attention is paid primarily to the flowers that are found growing together at one time. This is, of course, best arranged chronologically, a separate book being kept for each year. By reference to any one time we can see just what was found in a certain place at that time. Such a book, or series of books, will, however, require an index, which should be kept up to date on the file system, so that, by looking, *e.g.*, under the heading "Daisy," we can find instantly just when this particular plant was observed in any particular year.

GETTING TO KNOW THE SNIPE AND PLOVER

All the birds hitherto dealt with in this series of chapters have been members of the Passeriformes; now, however, we learn of two very popular members of the Charadriiformes—the lapwing, green plover or peewit, as it is variously styled, and the snipe. They are described here together mainly because of the frequency with which they are seen in each other's company, though they have many other points in common

Over the meadow lands, wheeling and twisting, turning hither and thither with ease and grace unequalled by any other bird, go the flocks of green plover. Early in the spring they cease to exist as flocks, but separate into pairs and make for their breeding grounds, often many miles from their winter haunts. Although we may see plover in the same place throughout the year, they are not always the same birds, and the vast flocks that feed on the water meadows in winter are probably visitors from the north, while our own local birds have gone far south.

Some of the birds, however, remain almost in the same locality year after year, rearing their families and spending the winter in the same fields. Wonderful as are the aerial performances of the great flocks of winter, they are as nothing compared with the amazing flights of the male birds during the courtship period of early spring. The plover's wings are long but have very rounded ends, a feature which makes the bird absolutely unmistakable in flight. During the mating season the male birds indulge in aerial antics for hours at a time. They rise and fall, dash towards the ground as if utterly out of control, sail upward in long sweeps, hurtle along just above the surface of the ground, twisting from side to side, suddenly rising, turning and diving again, the wings apparently flung limply against the wind. From time to time the love-call, a wavering, clear, musical whistle, is uttered on the wing, and then the bird drops suddenly earthwards, alights gracefully and runs towards the female, the crest erected, the wings spread and quivering. Then begins a further part of the display, in which the male scrapes out a miniature nesting hollow, sits in it, and rises up and shows off the beauties of his plumage, uttering low cries all the while. When in flight the birds make a soft, beating sound with their wings—a sound very similar to that made by the wind itself in the trees of the fir woods.

In appearance the green plover, or lapwing, as it is also commonly called, is a very handsome bird. The crown, face, breast and throat are black, and the upper parts look black in a dull light, although they are actually

SETTLING DOWN

Birds that build on the bare ground—one such is the lapwing seen below—are very careful to settle on their eggs with the minimum of disturbance. When she has finally settled, this bird will be almost invisible, for her brightest plumage is hidden and the feathers of the back tone perfectly with the background.

Ian M. Thomson

green with a metallic sheen of purple and bronze. The underparts are white, and the white extends up the sides of the neck, so that the bird seems to have a smooth, black shirt-front. The tail appears to be black, but is really white with a very broad band across the end. The erectile crest is blackish-green; in the female this crest is much smaller, and the hen bird also has narrower, less rounded wings. In winter the birds are whiter, for the light colour extends up the throat, and there are light markings on the upper parts as well.

The plover is one of those birds that choose the flat and open ground as a nesting site, and the nest itself is only a slight structure. A hollow is scooped out very often among the furrows of a field, or in the heather of the moorlands, or under a tuft of grass in the water meadows.

A few grasses constitute all the materials of the nest; these seem to be used more for decorative than domestic reasons, although occasionally the birds will try to build a circular saucer of this flimsy material. The eggs, almost always four in number, vary enormously in colour, according to the situation of the nest. On heath country the ground colour is darkish buff; this is replaced by an olive-green when the nest is on the meadowland.

RETURNED HOME

Arriving back at her nest after a short absence, it may be in search of food, the snipe approaches her nest with slow caution, so as not to betray its site. The striped plumage makes this a hard bird to detect, even when on the move, and when it is sitting immobile on its nest it is well-nigh impossible to say which is bird and which is the surrounding heather.

Arthur Brook

In either case the eggs are mottled with darker colour, especially at the larger end. Rather pointed in shape, they are, in fact, typical of those of all the wading birds and the other plovers. They are considered a great delicacy by gourmets, but their collection for eating purposes is now forbidden by law. The eggs of certain sea-gulls are, therefore, sometimes substituted and the epicure is, as often as not, completely deceived.

Nests that Defy the Searcher

Built as it is on the bare ground, the plover's nest is extremely hard to find, and we may quarter a field again and again, the anxious parents wheeling wildly overhead and occasionally dashing at us with cries of alarm, without discovering it. Success may come through our almost stepping on the eggs, or, occasionally, through marking the place from which we see a bird rise. As a rule, however, the plover, when leaving the eggs, proceeds to run quietly for some way before getting up; it also alights a considerable distance from the nest and then runs to it. When we disturb the birds, they appear as though they come out of the ground, and it is almost impossible to see them get up. They fly round and round with an anxious call, interpreted as *peee-wee*, and often repeated. It is this call which has given rise to another of the lapwing's common names, that of peewit.

In winter these birds collect into enormous flocks, several thousands strong, and descend on the farmlands and on the wet meadows where there is plenty of food. No other bird approaches the plover in value

S. Crook

FEEDING TIME

Even nesting birds must cease their brooding from time to time and satisfy their appetites, and these two snipe are enjoying a hasty snack in the shallow waters of a moorland pool. Notice the long, slender bill, adapted for digging in the mud, and the long legs which permit of the body being kept above the water.

to the farmer, for it feeds almost entirely on insects and grubs that are troublesome pests; it never eats crops. The evolution of these flocks, though not so striking as those of the even larger masses of starlings, are very fine, being especially effective when the birds are seen high up against some black rain cloud. Then the white of the wings catches the light, and the whole flock looks like a flickering cloud moving rapidly across the sky. At times the flocks fly very high, far out of sight, especially when migrating; those that we see are often flocks that have been forced down by adverse weather conditions.

Features of the Wading Birds

THE plover is the first bird to be dealt with that has not belonged to the great order *Passeriformes*. It is a member of the very large order, *Charadriiformes*, which includes also the wading birds. A feature of these birds is that they are especially well adapted to wading and to running. There are as a rule only three toes, all of which point forward, and the fourth, if present at all, is purely rudimentary. The flight is strong and swift, and some members of the order accomplish every year the most wonderful feats of migration. In the wading birds proper, the bill is long and adapted to the taking of food from thick mud and water of some depth.

A very common bird of the true wading type is the snipe, also known as the common snipe. It is very often found in association with the lapwing, and, in fact, where the one is we may be almost sure of finding the other. As we walk across the marshy meadow, or through the long, dry grasses and bents of the heathy boglands, a smallish bird gets up, often almost at our feet, and makes off with very rapid zigzag flight, uttering a single, loud, harsh cry. This is the common snipe, a bird of very individual character, popular alike with naturalist and sportsman.

In the spring, if we visit the moorlands and wet meadows where the snipe breed, we may hear a curious whirring sound that comes apparently from the sky. After a while this sound may be traced to a number of snipe flying to and fro overhead, and we may notice that it only occurs when they fly, almost dive, steeply downwards. This sound is called drumming, and it is, so ornithologists tell us, the love song of the snipe. It is caused, so far as is known, by the vibration of the two outer tail feathers, which are held out at right angles to the rest of the tail during this steep dive. The whole tail is spread wide, and the wings are only half open during this performance, which may be repeated again and again throughout the day, and especially in the evening. The snipe has another call, an oft-repeated sound that may be transcribed as *chip-per, chip-per*; this may be uttered from the ground, from a perch, or when the bird is on the wing.

O. G. Pike

'FREEZING' TO LIVE

When surprised in the open the snipe often chooses to "freeze," or lie perfectly still, rather than expose itself by flying away, for it is fully aware of the protective coloration of its plumage. Even when the ground is covered with snow, as in the above photograph, the bird is not easily discovered unless it moves.

Like the plover and other wading birds, the snipe nests on the ground. The nest is a cup-shaped hollow in the thick grass, usually half hidden beneath a tuft of grass or heather, and lined with fine grasses. The eggs, normally four in number, are smaller than those of the plover, and more pointed. The ground colour is olive-brown, and there are a number of spots and blotches.

In colour the snipe is brownish. There is a pale stripe on either side of the head and one along the centre of the head; a darker streak runs from the beak through the eye. The underparts are light, with a large number of longish marks on the throat, and transverse streaks lower down. The whole back is darker brown, with pale streaks on the mantle and blackish markings on the wings. This striped coloration renders the bird practically invisible if it sits very close in the heather, and the young birds are even more protectively coloured; they are browner and the general tone is warmer. The tiny snipe babies are able to run within a few hours of hatching, and it is impossible to discover them once they are in the heather. If, however, we are lucky enough to happen upon one we shall find that it sits so close and quiet that it will allow itself to be picked up in the hand rather than make any movement which might give it away. This habit is common in many birds and is a feature especially characteristic of young birds of the order to which the snipe and plover belong.

Two other species of snipe are found in the British Isles, both of these being rare. The great snipe is a passage migrant, having been recorded from all over the country in the autumn months. Fond of drier localities than the common snipe, it is slightly larger and may be distinguished by its more strongly marked underparts. The jack snipe is a much smaller bird, a regular winter visitor and passage migrant. Besides its much smaller size, its slower flight and the absence of the pale stripe in the middle of the head will serve to distinguish it.

Revealers of Nature. 8

GEORGE BORROW

It is not so much the revelation of the details of Nature-study — the close observation of the habits of animals or the idiosyncrasies of plants — that we owe to George Borrow, but the literary discovery of the richness and fullness of the world about us—its brawling and teeming denizens, the tonic of the fresh air, the sedentary beauty of hedgerows—and the brave life of the gypsy wanderer whom it surrounds. The breeziness of "Lavengro" shocked the carefully-nurtured novel-readers of the 1850's, to whom a draught of ale at a wayside tavern, followed by a moonlit walk through the woods, was a scandalous, even immoral, proceeding, and the man to whom the commonness of urban existence was anathema was branded as "vulgar." This "vulgar and immoral" brawler and vagrant was, however, always an ardent Protestant, and of a deeply religious temperament. He spent a large portion of his life, indeed, as an agent of the British and Foreign Bible Society, his travels in its service being immortalized in his book, "The Bible in Spain."

But to his contemporaries his Protestantism was extended too far into non-religious life; he protested against their shams and so-called "gentility," and was therefore politely but firmly ignored. Nevertheless, he threw open a window on Victorian life through which a gust of wind from the mountains and heaths entered to blow away many urban cobwebs and prejudices. To the impetus given by Borrow can be directly ascribed the foundation of many "open-air" organizations.

Borrow's life was, as might be expected, one of adventure. Born in Norfolk in 1803, the son of a soldier, he passed his youth in wanderings in company with his father's regiment, and after five years as a solicitor's clerk—a post which he hated—went to London in 1824. As an agent for the Bible Society from 1832 he visited Spain, Russia, Portugal and Morocco, becoming closely acquainted with the gypsy life, language and lore. He settled on Oulton Broad, Suffolk, in 1840, but his restless spirit prompted him to move on again four years later, and he passed the rest of his life in travel in south-east Europe, in Wales and in England. He died at Oulton on July 26 1881.

Probably no "foreigner" was ever taken so completely into the confidence of the gypsies as was Borrow, to whom their language and customs became as his own. "The Romany Rye," "Wild Wales," "Romano Lavo-Lil," and "The Zincali" are testimonies to his sensitivity to natural beauty, his deep knowledge of human, and, especially, outlawed nature, and his love of those aspects of existence which are typified by boxing and horse-riding.

Eccentric and whimsical as he was, he had a magnificent grasp of literary style, while the activity of his mind and body was scarcely equalled in his age. To ride wildly with Borrow over the moor, to sit with him by the camp-fire on the road at night, or to wander with him through England and Wales is to receive a revelation of Nature that no other writer can give. Though largely out of touch with his own age, he is closely in touch with ours—a Gil Blas with a touch of Bunyan.

THE BLOODTHIRSTY WAYS OF THE STOAT

LOOKED at from one aspect, the stoat—or ermine, as it is known to furriers—is quite a prepossessing little animal, but most people cannot forget that other aspect which is revealed when, driven by hunger or by something akin to blood-lust, it pursues the silly and helpless rabbit

A WIDE green and silver river meandered through the length and breadth of the plain, and here and there large islands of meadowland could be seen—meadowland cut off from the rest of the countryside by the winding of the waters. On one of these islands, somewhat larger than the rest, grew willow trees, the roots of which held the soil together against the erosive action of the river. On this island quite a large community of rabbits had been left isolated several years before, when the neck of a narrow peninsula had broken during the swirl and rush of a winter's flood. The rabbits, thus cut off from the rest of the world, had burrowed the island from end to end, and were in danger of extinction through shortage of food, owing to the fact that the earth thrown up by them on the surface had killed off most of the already somewhat scanty grass.

On a summer's day, when the river was calmer than usual, two stoats came to the bank, and with their tiny, narrow eyes and acute, highly sensitive noses were able to realize the existence of that colony of rabbits herded together on the patch of land in mid-stream. There seemed to be no hesitation on the part of either of these two thin-bodied, swiftly-moving creatures. As if by some word of command they plunged into the water and swam together, heads well down, legs working as fast as they could go, for the shore of the island. The current, however, was a little stronger than they had anticipated, and before they were half-way across it became only too clear that they would experience great difficulty in reaching their objective. The swirling current had carried them well past the island when an unseen backwash plucked them from its clasp, and, driving up-stream in the lee of the island, deposited them on the shore.

Murder on a Wholesale Scale

NOW began such a slaughter of the rabbit community as must take place more commonly in the dreams of stoats than in the reality of their lives. In and out of the burrows ran the sleek forms of the two attackers, while the squealing rabbits, young and old alike, fled in terror before them. But there was no place for them to flee to. Round and round the island, darting now this way and now that, in at one hole and out at another, they ran, with no hope of escape.

The slaughter went on. Details are unnecessary, but within two short hours every rabbit on that island had been killed, while two overfed and gory stoats crept to the water's edge to drink and clean themselves. Night came, and hid the two murderers from view, but by the time the sun rose on the following day they had gone, leaving the island strewn with the corpses of the rabbits they had killed. Only very few of these had been touched as food. This story is typical of many illustrating the bloodthirsty and utterly ruthless nature of the stoat. "They kill," the country folk say, "for the sake of killing." But even though this may appear to be so, it is unlikely that it is a true statement of the case.

WITH every nerve more alive, and every sense, it would seem, more acute than in most animals, the stoat is not really so bloodthirsty as it is highly-strung. An attack made for food on a single member of a community would probably rest at that, were it not for the fact that the relatives and friends of the deceased will persist in making such a fuss. It is quite possible that nervousness and irritation at the noise made by the squealing rabbits or screeching chickens is the sole reason why the stoat carries out such massacres as that described above, and does not limit itself to a kill of reasonable proportions.

No animal in a wild state will kill for the mere delight of killing. The stoat's only way of gaining its food is by attacking and eventually eating its neighbours of

CAUGHT RED-HANDED

Partridge eggs are a delicacy no stoat can resist—hence the hostility of the gamekeeper to the little beast. The nest of fifteen eggs seen in this photograph has been carefully concealed among the dead bracken-fronds, but the stoat's sensitive nose has set all the precautions at naught.

Newman

AT FULL HEIGHT *J. A. Speed*

In this erect posture the litheness and agility of the stoat are well demonstrated, while the white underside of its body can clearly be seen. Stoats take up such attitudes when endeavouring to catch birds flying just above their heads.

the woodland. It is unlikely that the desire to kill, provided by Nature in order that the little animal may be able to live, is ever greater than the actual desire for food. In a domesticated or even semi-domesticated state, where the food is often provided without any effort being made on the part of the animal, the latent desire to kill, still surviving though no longer required, may sometimes come to the surface and show itself in the form of a sudden outrage or murderous attack upon an entire colony of possible meals. Sickness and perhaps even some form of hysteria are other explanations of this problem of wild life behaviour.

The stoat (*Mustela erminea*), or ermine as it is called when killed for its fur, is one of our smaller animals, its usual length being about fourteen inches, of which about four to five inches make up the long, though not bushy, tail. The colouring is very distinct, the upper parts being tinted a red-brown and the under surfaces in more yellow tones. The tail is of the same coloration as the upper surface, except at the tip, where is a characteristic tuft of long black hairs.

The colouring of the stoat's fur in cold and dark northern climates has made the little animal much sought after by trappers and hunters, who can sell the skins for very considerable sums of money. In the extreme north of Scotland, and in Norway, Finland and Russia the stoats change their colouring during the winter months and take on that of their surroundings by turning a beautiful white. These ermine are much prized by the followers of fashion, and every winter hundreds of thousands of them are trapped and shot in order to supply Paris, London and New York with the required number of skins for the fur coats of those who can afford them. Just how many of these skins are needed may be guessed when it is realized that every black tassel on an ermine cloak is the tip of a stoat's tail. This tip is the only part of the skin that does not change its colour in winter.

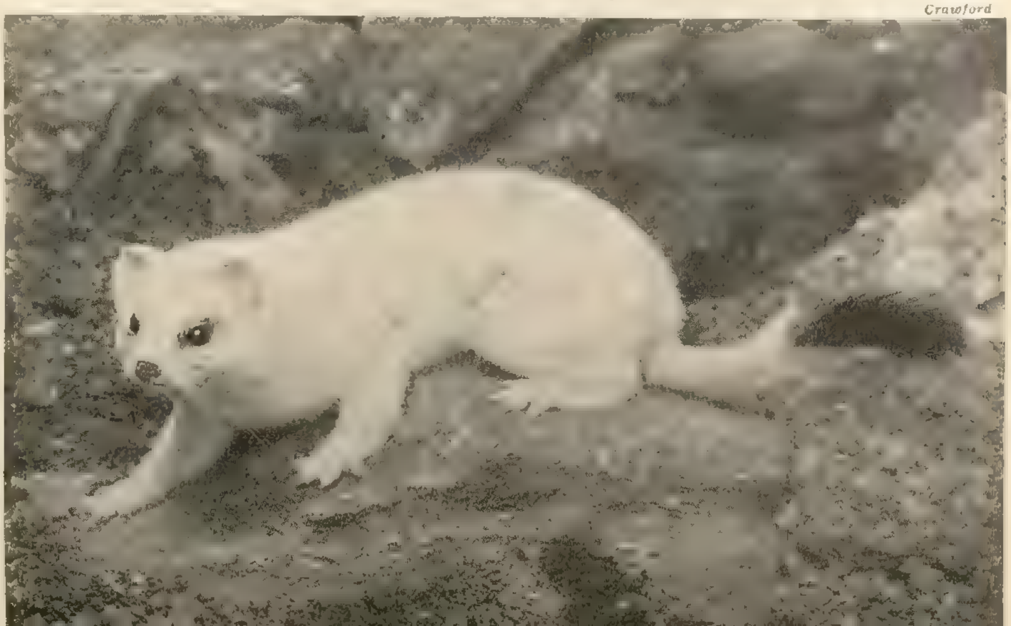
Why Hair Goes White

METCHNIKOFF, the Russian scientist, carried out a large number of experiments on the colouring of hair, and in doing this he made extensive use of the fact that the stoat changes from brown to white during the winter months. He discovered that the whitening of the hair which, except in albinos, is an accompaniment of old age in Man, and the same change in animals which have adapted themselves to a life in snowy regions are both due to the action of phagocytes. In the whitening of the human hair a number of these minute organisms kill and consume the entire contents of the pigment cells and then retire back into the skin of the scalp, or quit the body altogether. This leaves the pigment cells completely empty, and the reflection of the scattered light which falls on them makes the hair appear white, in the same way as the crystals of snow produce this effect. But in the whitening of the stoat's winter coat only the pigment granules in the cells are consumed;

DRESSED FOR THE WINTER

In its colder habitats the stoat at the approach of winter changes its brown coat for one whose whiteness matches the snow-covered ground. This seasonal change is seldom seen in British stoats, and then only in the extreme north of Scotland.

Crawford



the other contents remain. The fundamental difference between this seasonal whitening and that of human old age lies in the fact that in the latter case the pigment cells are destroyed, while in the former their effect is merely suspended.

Whitening in the Winter

RARELY, if ever, does the British stoat show any whitening, except in very exceptional winters and in the extreme north of Scotland. The lighter portions of its fur often take on a primrose or almost sulphur tint, but that is usually as far as it goes. Such lightening of shade as does occur shows that it is the portions where there is most fatty tissue underlying the skin that are first affected, and it sometimes happens that a stoat will go pure white except for the crown of the head, the ridge of the back and a ring round each of its eyes.

CAREFUL POSE

Although the stoat averages about fourteen inches in length, about a third of this is taken up by the long-haired though not particularly bushy tail, the black tip of which is one of the little animal's most characteristic markings. The white shoulders and somewhat blunt face are other signs by which the stoat may generally be recognized.

Like the polecat, the stoat is able to eject an extremely objectionable odour from its scent-glands when annoyed or frightened. The American skunk is another animal which develops the same protective secretion, while all the British Mustelines are able to do so to a certain degree.

HUNTING along the hedgerows, the rivers and the brooks, stoats will eat anything from chickens to fish, of which they are extremely fond. An eel or other fish set as bait in a trap makes a very effective way of catching these animals if such a course should ever prove necessary.

Stoats are widely distributed throughout the world, their range extending far into Asia, to the Alps and the Pyrenees, and across Europe to the Arctic shores in the extreme north. There are local races to be found in many different places, one of which is Ireland. Here a smaller breed of stoats can be seen, with certain variations in the colouring, and some naturalists have given them a separate species name—*Mustela hibernicus*, or the Irish stoat. Another local race in the Isle of Jura, in the Inner Hebrides, has been given a name of its own, but neither of these two local races is universally accepted as constituting a really separate species.

END OF THE HUNT

The rabbit on whose track a stoat once fairly sets itself has but a meagre chance of escape, so relentless and untiring is the agile little hunter. Frightened out of its wits, the rabbit is soon pounced upon and dispatched by a bite through the back of its neck.

Frances Pitt

It is only in England, where the practice of preserving game is carried on to such a great extent, that the stoat and the other members of the *Mustelidae*—the weasel, polecat and marten—are looked upon as vermin and their names given a sinister meaning. In Swabia, for instance, the word *wuseln*, meaning literally "to skip about," is a term of affection, while the Italian for a weasel, *donnola*, means "little lady" and the Spanish *comadreja*, a "god-mother." The Bavarian name, also beautifully sounding in itself, describes the stoat as a *Schoentierlein*, or "pretty little animal." In certain parts of this country, where the shooting of game does not play any part in the lives of the local inhabitants, the name "fairy" is often given to stoats, weasels and martens without distinction.

COMMUNISTS OF THE WOODLAND ANT-HILL

POLITICAL philosophers in every age and of many different schools have gone to the ant and considered her ways—have sought some light on human problems, some guidance in human organization, in the study of the ants' truly remarkable social and economic arrangements. Just how remarkable is their polity may be gathered from what is written concerning the wood ants below. Other members of the ant tribe are dealt with later

SOONER or later the rambler in the pine woods is bound to come across a wood ants' nest, although at first sight he may not recognize it. During winter these huge mounds of pine needles, twigs, earth and bits of débris show no signs of life, and a townsman would be justified in ignoring them as mere heaps of refuse. As warmer days approach, however, the first adventurous members of the ant community appear, and by early summer the surface of the heap is a seething mass of shining ants, their scaly armour gleaming even in the shade of the pine wood, so that if we look too long at the ant-hill we become dazzled.

The organization of the ant community has been the subject of innumerable books, and was one of the earliest of all insect phenomena to attract the attention of Man. Even the smallest nest of these amazing creatures is full of fascinating material for the student, not only of insect life, but of far wider subjects. Many philosophers have gone to the ants for theories and ideas, but the mystery of their ways will stand centuries more of painstaking research before it is fully elucidated.

FROM their size, their wide distribution, and the fact that they live in particularly attractive surroundings, the wood ants are without doubt the best species for the naturalist to begin work on. Nor is it necessary for us even to open up the ants' home in order to begin our studies, for there is much food for thought and material for research even on the surface of this vast city.

A normal wood ants' nest is a largish heap of débris about two feet high by as much as five or six across. Its actual dimensions are not easy to ascertain, for the borders are irregularly defined and the nest straggles shallowly on either side, and is also continued for some way below ground—as far, in fact, as it rises above.

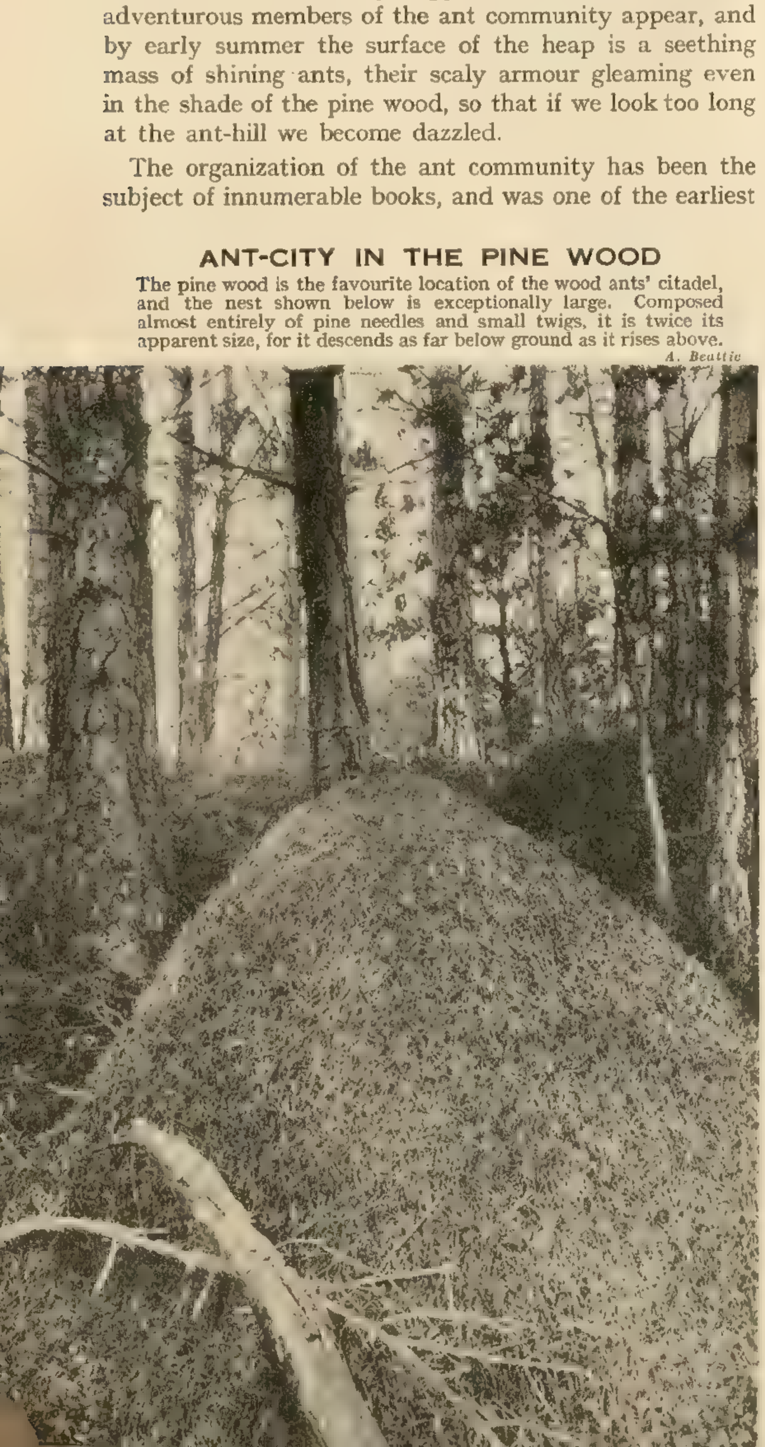
The inhabitants of the wood ant community are divided into the same groups as we have already seen in other social insects, such as the wasps and humble-bees. There are workers, males and queens, but there is more than one queen in each nest, so that the community is not centred round one particular ant, but is more of a state, in which every individual is working for the good of the whole. There may be several queens, or even several dozen.

Ants and Bees Compared

ALL true ants are members of the order *Hymenoptera*, to which also the wasps and bees belong, and their colonies show that in some ways they are far more advanced than even the honey-bee. We say "true" ants because the so-called "white ants" that wreak such fearful havoc in the tropics, and build the enormous nests of which one frequently sees pictures, are not ants at all, nor are they found in the British Isles. The resemblance of the true ant to a bee or wasp may not be obvious at first, but a little study will show us that they are really very similar. To begin with, the ant has the same narrow waist that we find in the bees and wasps, and the same thin legs, large head, and well-divided body. In the ant, the antennae are long and elbowed, one segment being extremely long and the rest short. The powerful jaws are very evident and are of the type adapted to biting that we saw in the wasp. In this they differ from the bees, whose mouth-parts are especially suited to sucking nectar, though some bees also use them for biting. The stinging powers of the ant are also reminiscent of the

ANT-CITY IN THE PINE WOOD

The pine wood is the favourite location of the wood ants' citadel, and the nest shown below is exceptionally large. Composed almost entirely of pine needles and small twigs, it is twice its apparent size, for it descends as far below ground as it rises above.
A. Beattie



H. Bastin

HELPLESS CHILDREN

In its early stages the wood ant is a particularly helpless creature, and the larvae (left) often have to be carried from place to place by the workers. The pupae (centre) are enclosed in the cocoons (right), the weaving of which is among the duties undertaken by the larvae. These cocoons are the "ants' eggs" on which goldfish are commonly fed in home aquariums. (× about 5.)

bees and wasps; the acid which is responsible for the stinging feeling is named formic acid, *formica* being the Latin word for ant.

The ants which we see swarming in masses round the nest at most times of the year are wingless, and it is probably this fact which seems most to separate them from the bees and wasps. The males and females, however, are winged. At certain seasons, when conditions are suitable, the males and females emerge from their subterranean home and indulge in one wild nuptial flight, then returning to earth and breaking off their wings. This is a familiar phenomenon in the country, where these apparent swarms of flying ants may cause some inconvenience and not a little alarm, although actually they are harmless.

ROYAL PAIR

These winged ants are the male (above) and female or queen from which a new swarm may be bred. The male, having fertilized the queen on one brief nuptial flight, dies, whereupon the female comes to the ground, loses her wings, and either returns to the nest or founds a new colony. (× about 3.)

In the wood ants the procedure is exactly similar to that of the more familiar garden ants, though pairing takes place after this nuptial flight. The winged males and females, however, may be procured by plunging one's arm into the midst of the nest and removing a portion of it. The ants crawl out of the débris, and these two fertile forms can then be separated from the workers. The fertile males are blackish-brown in colour, clothed with short hairs; their legs are reddish. The fertile female is reddish-brown and larger than any of the other ants; her abdomen is polished and very shiny. Among the ants hauled up from the depths of the nest may also be some wingless, fertile females that have already enjoyed their brief period of freedom, and are now back in the nest, working hard at their duty of producing eggs. The fertile males do not return home after their flight; they are eaten by birds, killed by other ants, or die a natural death of starvation. Some of the fertile femalés, too, do not return to the nest, but are left to found new communities or die off.

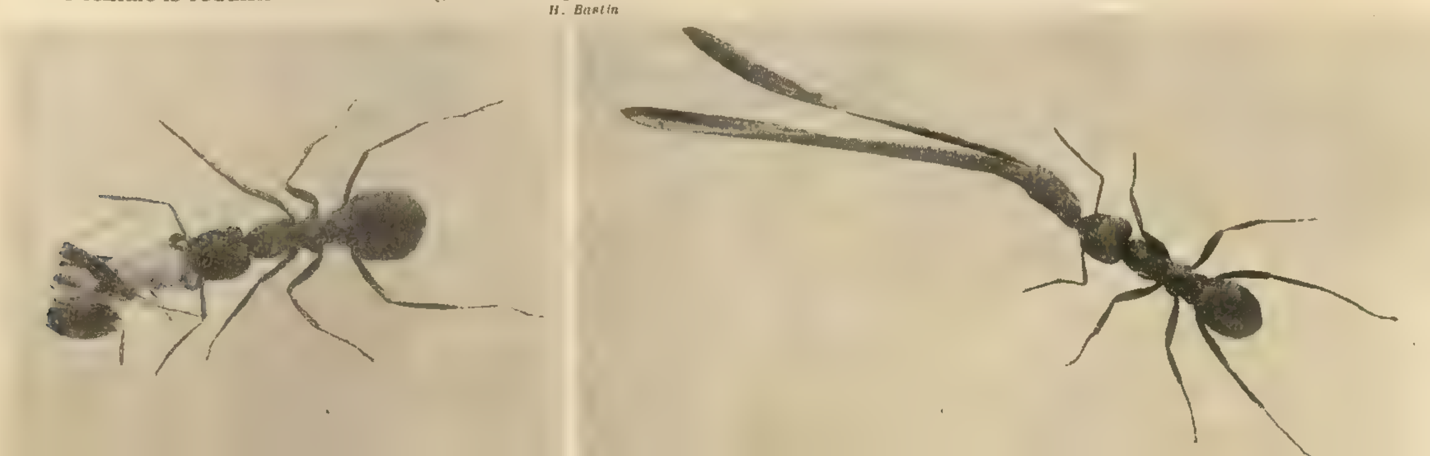
As in the bees and wasps, described in pages 155 and 24 respectively, the workers themselves are females in which the sexual organs have never been developed. In compensation for this, the worker has far more highly developed senses, for the queens are almost incapable of fending for themselves and the males are of no use except in fertilizing the queens.

The workers carry out all the normal duties of the community—feeding the young, tending the queens, fetching food, seeking for supplies of material for the mound, and clearing away refuse from within the nest. Their business it is also to guard against the raids of ants emanating from other nests, and to attack any enemies that may assault the community.

FEATS OF INSECT STRENGTH

Here we see the enormous burdens which ants are able to carry. Immediately below is a worker bearing a pine needle to add to the nest, while the insect on the left is engaged in the task of removing from the nest a dead fellow-worker. Such hygiene is a regular feature of ant communities. (× about 3.)

H. Bastin



A. E. Smith

AT DEATH-GRIPS

Ants have their private quarrels as well as wars, but whether the fight pictured above is an "all-in" wrestle resulting from a private feud, or an isolated incident in a war, we cannot be sure. Though he is beneath, the lower ant is not yet defeated, for his jaws are open in an effort to put in yet another bite. (× about 12.)

In its life history the ant greatly resembles the wasp and bee. The eggs, laid by the fertile queens, are kept in properly tended nurseries. They are housed during the hours of darkness in galleries deep down below the surface of the soil, but every day hosts of workers carry them to the upper galleries, where they can benefit from the warmth of the sun. Unable to feed themselves, they are given honey-dew regurgitated from the stomachs of worker ants. This honey-dew is collected by the ants from the aphides which swarm on the trees and plants about the nest. Having filled themselves with sufficient "milk" from these insect "cows," the workers return to the nest and feed the young ones. They feed also any other workers that are in need of sustenance, as well as the queens, who require far more nourishment than the rest of the community.

Eggs and Cocoons of the Ants

When fully grown the larvae weave themselves tough, oblong little cocoons, in which they change to pupae and then to adults. It is these cocoons that we see whenever we disturb an ants' nest. Popularly but quite erroneously known as "ants' eggs," they are sold as food for cage and aviary birds, gold fish and other pet creatures. The real eggs may be distinguished by their much smaller size—though they are large compared with the size of the adult insects—and by the fact that they are of a dead white colour, whereas the cocoons are buff. When there is any disturbance, such as may be caused by our stirring the nest with a stick or removing a part of it so as to see the inner galleries, innumerable workers may be observed removing the eggs, larvae and cocoons to a place of safety.

Signs of Economic Activities

If we follow some of the workers that leave the nest we can discover a number of most interesting things about the way in which they set to work. First, it soon becomes obvious that they follow very definite routes along which there is a constant stream of ants coming and going. By tracking them along one of these we can find what they are doing at the other end. For instance, we may discover a swarm of aphides; these are carefully "milked" by the ants, who then return home and feed the grubs. There may be a stream going to an old tree, from which oozes a mass of sticky sap; round this swarm more ants, feeding and filling themselves with food. The road may end in the body of a bird that is being gradually eaten to pieces, for ants are great scavengers.

Often two ants will be seen to stop and apparently have a conversation, each individual tapping the antennae of the other with its own antennae. These conversations are carried out only in certain circumstances, particularly when one ant requires food from the other. The food given, the two ants pass by and go on with their own especial jobs. Along every road there are to be found individuals carrying sticks, pine needles and other objects that are of obvious structural value. These are not used entirely in augmenting the outside fabric of the nest, for they may be needed to act as supports within. Even inside such a well-armed community as that of the wood ants there are numbers of enemies, some of which are tolerated for no apparent reason, and some of which actually feed on the structure of the nest! Among the guests to be found in ants' nests are many aphides, the insects from which the ants get their honey-dew, and which they keep carefully herded together, like cows in a byre. Some of the guests, however, are not so welcome, and may be regarded as parasites which for one reason or another are able to survive even in the very midst of their foes: among these are many species of beetles.

HINTS ON ANT OBSERVATION

If we are prepared to undergo the slight inconvenience of a few stings, wood ants are among the easiest insects to watch, but to see them at close quarters we shall have to disturb the nest. So large, and so loosely constructed is it that there is less chance of seeing its actual structure than in the case of those ants whose castles are made out of the actual soil. We must, therefore, be content with delving into the nest and removing a large handful of material. We can then examine its contents.

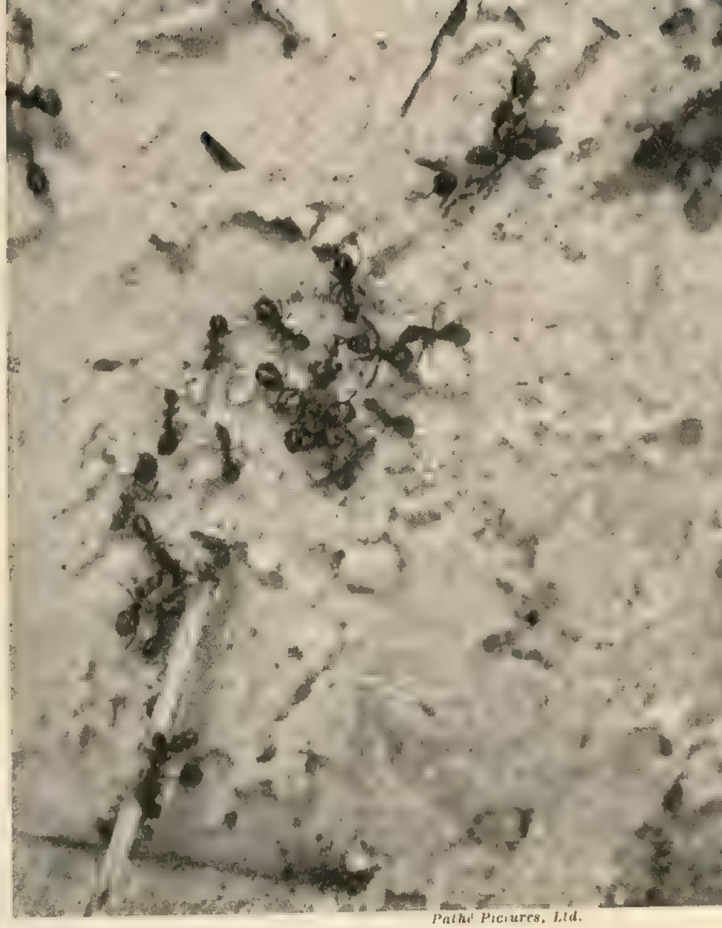
Guests of the Ants

Mention has been made in the above chapter of the guests of the wood ants, and for these we should keep an especially sharp look-out. One of the most important of these is the fat, greasy, yellow-white larva of the rose chafer, a fine beetle that is described in a later chapter in this series. Another beetle whose larvae inhabit the wood ant nest is known as *Clythra quadripunctata*. This insect might well be taken for a large, rather elongated lady-bird, for its red elytra bear four black spots. The larvae act as scavengers within the wood ant nest, eating vegetable débris.

Looking into the Nest

For observing the inside of the nest, a good plan is to take a large sheet of plate glass, say two feet six inches square, and dig away half of the nest, placing the glass against the remaining half. The ants then continue to live in the other half, and their galleries may be observed. The notebook will be in constant use at first, and if we are able to visit the nest only occasionally, notes should be made every time. If, on the other hand, there is ample opportunity to study the nest, once we have become acquainted with the normal order of things in the ant community, it is necessary to make notes only when some strange, new event is observed.

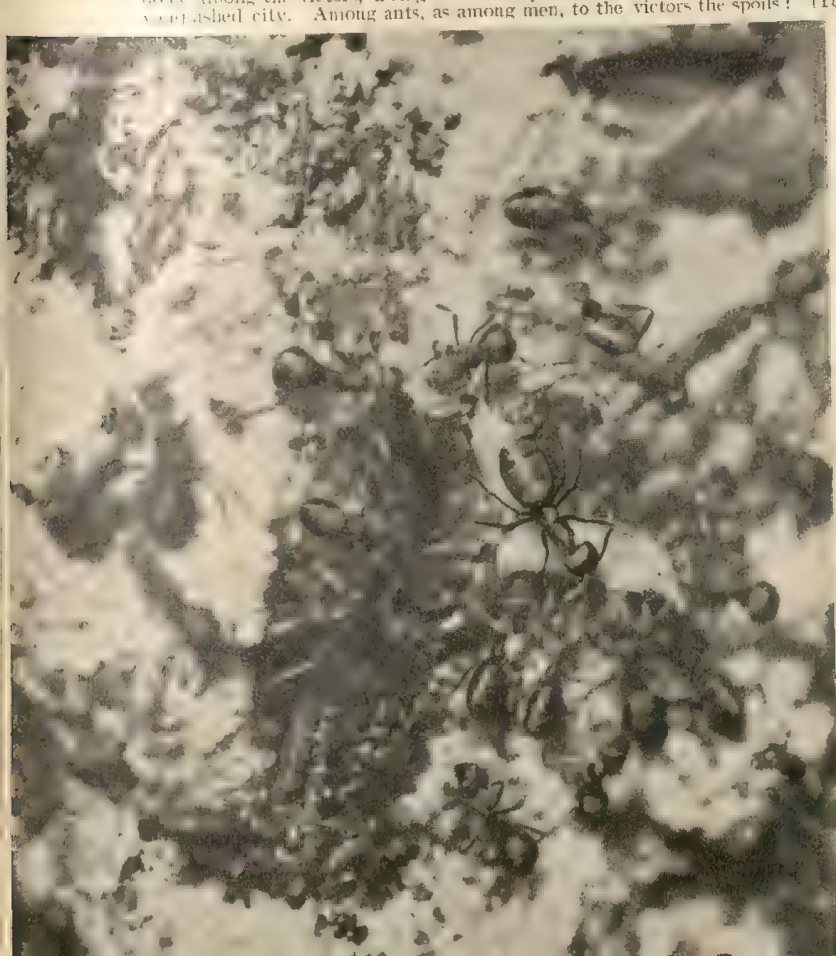
At the season when the winged males and females are about, it is worth while watching the females that alight after their nuptial flight. Do they return to the nest? Are they welcomed by the workers? Are they, on the other hand, forced to leave and start a new colony of their own, in which case they must begin from the very beginning, as did the queen wasp and humble-bees described in Chapters 1 and 3 of this section (pages 24 and 155)? All these and many other absorbing questions may be answered at the price of some patience and a few stings!



Pathé Pictures, Ltd.

WHEN WAR IS DECLARED AMONG THE WOOD ANTS: SCENES AT THE FRONT

Occasionally it happens that war breaks out between two ant communities, and the four pictures in this page illustrate happenings in the war zone after hostilities have begun. In the first picture (left above) a scout from the attacking force is being "interrogated" by two guards from the opposing camp. The adjoining picture shows a skirmish in progress; ants are fighting in small and scattered groups, and casualties are visible in various parts of the battlefield. In the next picture (bottom left) disaster has overtaken one of the contending armies in the shape of the loss of their queen. Distinguished by her large size, the lady is seen being carefully herded back to her new home among the victors, a ring of workers preventing her escape. In the final picture workers are removing a vast balk of timber from the vanquished city. Among ants, as among men, to the victors the spoils! (Top photos, × about $1\frac{1}{2}$; bottom left, × 2; bottom right, × $1\frac{1}{4}$.)



ORCHIDS THAT FLOURISH IN MARSH & MEADOW

IN the sixth chapter of this series (page 174) is described and pictured the early purple, the commonest of our wild orchids. Now we learn of other species of the orchid family—the green-winged meadow orchis, the marsh orchis, the spotted orchis, the tway-blade and the helleborines. The " insect orchids " are described in a later chapter

To most of us the word orchid conjures up a vision of a gorgeous, exotic flower, brilliant in colour and extraordinary in form, grown in a hothouse and costing, even as a single bloom, more than any other floral decoration. While this description is certainly true of the majority of the foreign orchids which are grown in hothouses, it by no means applies to our own native species. Many people are quite unaware of the number of beautiful and interesting orchids that are found in this country.

We have in the British Isles some forty indigenous species of orchids, of which the commonest and most widely distributed, the early purple orchis, has already been dealt with in an earlier page. Several of the other species are almost equally common, and the first we shall describe is the green-winged meadow orchis, a species often confused with the early purple. In this orchis the flower is of similar form to that of the early purple orchis, but usually slightly smaller. It gets its name from the fact that the sepals are marked with very distinct parallel green veins. The two lateral sepals often come together to form a sort of hood over the flower. The spur of the flower is shorter and stouter than in the early purple, and the colour is much the same, although very often a rather deeper, more bluish-purple may be noticed. The leaves are unspotted, narrower and smaller, and they grow to a larger extent up the stem, which they wrap round for the greater part of its height.

The green-winged meadow orchis is found in meadows and on the grassy slopes of hills, and is not so frequent as the early purple, although it is very widely distributed throughout England. Though normally fonder of dry soils, it is often seen in the same habitats as the marsh orchids, which are usually found in the situations implied by their name. The two very similar species of marsh orchis, greater and lesser, are not regarded as separate species by many botanists and will be grouped together here, since the differences between them seem to be by no means regular or easily visible to the beginner.

Orchids that Prefer a Moist Habitat

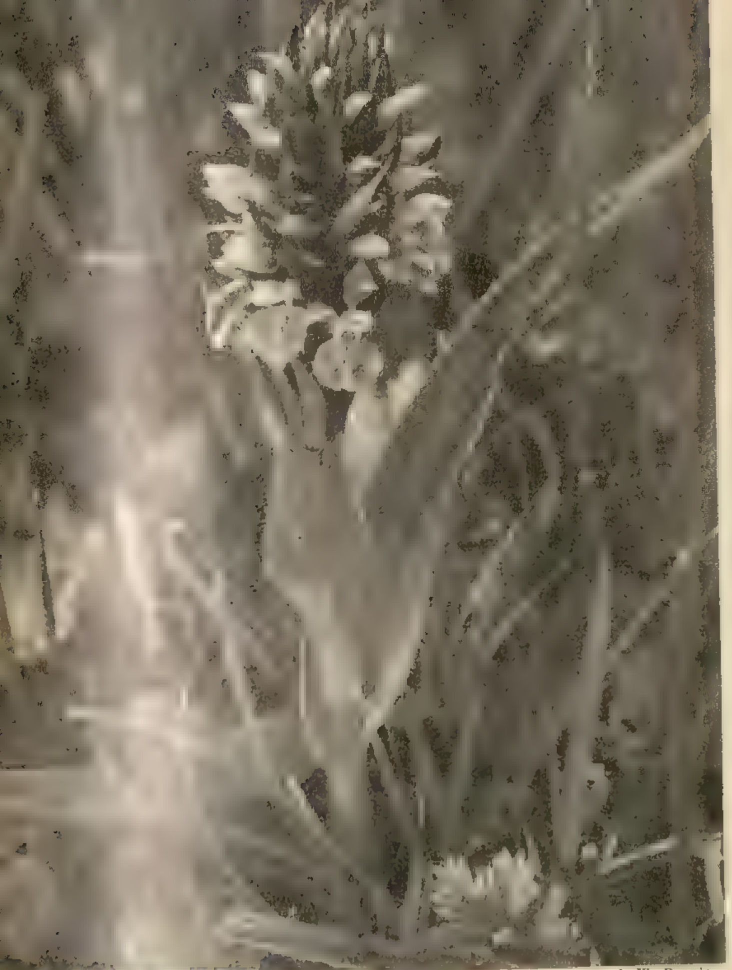
GROWING in riverside meadows, wet and badly drained fields and boggy places, though not usually on heathy bogs, the marsh orchis is one of our most conspicuous flowers. The stem rises often to a height of three feet and is seldom less than one foot in height ; at its top are borne numbers of fine purplish flowers of the same colour as those of the early purple orchis. The form of these flowers is also the same as that of the two kinds of orchis already dealt with, being in fact characteristic of the genus *Orchis*, to which they all belong. The lip of the flower is broad, and not so cut into lobes, and the bract which appears below each flower is long, often longer than the flower, and tapers to a point. The stems are leafy—the leaves being very erect and sometimes spotted with purple—and hollow, and later in the year, when the meadows have been mown for hay, they stand up and form a conspicuous feature of the coarse stubble.

At times the marsh orchis is found in such numbers as to colour the field, and the same may be said of another very common member of the genus, the spotted orchis. This is not so much a plant of the meadows as of the downs and heathy country, where it is often extremely noticeable, especially if the ground is

PURPLE TO WHITE

It is a noticeable feature of many typically purple flowers that they are subject to great range of shade variation, and this picture shows a series of the green-winged meadow orchis ranging from deep purple to almost white. Notice the short spurs of the flowers and the characteristic green-veined sepals.

A. W. Dennis



A. W. Dennis

FOUND IN THE MARSH

The marsh orchis pictured here is characterized by stout, upright growth, and leafy bracts are a prominent feature of the flower-head. The purple flowers vary enormously, and there are several sub-species. Notice the leaves, which are unspotted and come some distance up the stem.

damp and the heather does not grow thickly. The flowers of the spotted orchis depart from the rule in colour, being very much paler than those of other members of the genus, and thickly spotted and marked with darker reddish-purple, the markings often making a curious and complex pattern on the parts of the perianth. The lip is also more cut up into lobes, and may be as broad as it is long.

Sweet-smelling Spotted Orchis

On commons and heathy places the spotted orchis grows in great abundance, the pyramidal spikes of flowers attracting attention, especially early in the season before many of the flowers have opened fully. Later, when those at the base of the spike have finished blooming, the stem lengthens considerably and the inflorescence becomes rather untidy, there being brown, dead flowers below, then opened blooms, and, finally, a few buds still unopened at the top. The flowers have a sweet smell, very unlike the strong and unpleasant odour of many orchids. The leaves, which are more delicate and of a greyer green than those of the other species so far described, are spotted with purple.

Mention is made in page 176 of the manner in which the root of the early purple orchis grows, making two tubers, from one of which springs the stem. This type of root is found also in the green-winged orchis, but both the marsh orchis and the spotted orchis have a different type. In these two species the root consists of two tubers, each of which, however, spreads out into a number of finger-like lobes, which have a curiously human appearance when they are dug up and cleaned.

In a former chapter (page 200) many of the plants growing in a typical oak wood are described. Another of them, though one which is perhaps not quite so common as the rest, is an interesting little orchid known as tway-blade (from Old English, *twegen*, two). The reason for this name is obvious the first time that we come across the plant, for the neat pair of rounded leaves which

DETAILS OF THE 'SPOTTED'

Below are two photographs of the spotted orchis. The upper shows the plant's curious root-tubers, while in the lower are seen the flowers. The red-spotted tips of the latter make identification in the field an easy matter.

Ward and Tattersall

A. W. Dennis

CURIOUS TWAYBLADE

Common but insignificant—chiefly on account of the green colouring of its flowers—the twayblade is yet one of our most strange-looking orchids. Its form, suggestive of a little man, might lead the unwary to mistake it for the man orchis, a flower similar in appearance but found on the downs, not in the woods.

appear every year are unmistakable. Early in the spring these leaves may be seen, appearing at first as a spike similar to that of the wild arum, then opening gradually to display the flower stalk in the centre. It is interesting that although this may all be visible as early as March, it is often two months before the twayblade flowers are fully open. The single stem grows up and up until it may be as much as a foot in height, and when the flowers open they are seen to be small, not half an inch in diameter, and greenish in colour; they are borne in a loose spike, far looser than that of any of the other orchids so far described. The lip of the flower is bi-lobed, the two lobes hanging downwards and giving the whole flower an appearance very reminiscent of a tiny man. This plant must not, however, be confused with the man orchis, a far rarer plant which is confined to the chalk downs.

WHEN the stem of the twayblade is fully grown to a height of two feet or more, the leaves may be several inches above the ground, and then their characteristic ovate shape may be observed. They grow on opposite sides of the stem, and are tough and leathery, and have a number of veins which run from end to end in a characteristic fashion. This plant is fond of sloping ground, and is widely distributed throughout the British Isles; but a smaller relative, the lesser or heart-leaved twayblade, is much less common, being especially found on moorlands or high ground. The lesser twayblade has smaller, heart-shaped leaves, and flowers about a month later.

Another group of orchids of which we have several very handsome members is that containing the helleborines. Of these several species flower early in the year, one of them being the large white helleborine. This is a plant of the chalk country, where it is found not uncommonly in woods or on woody hillsides, its fine flowers and upright growth rendering it conspicuous. The sepals and petals are creamy-white and the whole flower is sometimes almost an inch in diameter. The parts of the perianth are curved inwards, with the exception of the lip, which curves outwards and is also produced at the back to form a characteristic spur. This lip is at first closed over the entrance to the flower, but it opens to allow of fertilization and then closes again. The arrangement of the organs is rather different in this genus, for there is no beak formed by the style, but the pollen-masses are borne above the sticky stigmatic surface. The method of cross-fertilization by insects is very similar to that described in page 176.

H. Bastin

ORCHID OF THE WOODS

Among the finest of our orchids, the white helleborine—of which the above is a specimen—is an upright, strong plant, whose flowers are much more regular than those of most orchids. There is no lip, and the perianth parts are all rather similar.

The large white helleborine has fine, broad leaves of a clear green colour. The lower ones are often six inches in length, being broad and lanceolate in shape. In this plant, too, the bracts at the bases of the flower stalks are very similar to the leaves in shape and structure, and are often of considerable size. They are, as a matter of fact, merely modified leaves.

The narrow-leaved helleborine is a very similar plant both in habits and in distribution. It is more delicate, the leaves being narrower and longer, and the flowers whiter and also narrower. In both these orchids the root system is not purely tuberous but consists of a creeping rootstock from which the stems arise in a leafy tuft.

MANIFOLD CHARMS OF THE HORSE CHESTNUT

Two varieties of chestnut are found growing in a wild state in Britain—the sweet or edible and the horse chestnut, whose fruits are the " conkers " of the schoolboys, inedible by both man and beast. Of the two the horse chestnut is by far the better-known, and below its characteristic features are set out and illustrated. The sweet chestnut is the subject of another chapter in this series

Few trees are so attractive at all stages of their existence as the horse chestnut. From the depth of winter, all through the spring, during the long days of summer and throughout the autumn the horse chestnut holds out to our view some especial delight. One of the factors, perhaps, that make it so well-known and so popular a tree is that its salient features have all an especial connexion with the days of our childhood. Among the very first and simplest experiments, for instance, that we ever carry out with Nature is with the chestnut buds. These spearheads of the tree, so brown and attractive in colour, so sticky and even more enchanting to the touch, may be picked while the country-side is still in winter's icy grip. Put in a jar of water, and watched day by day, they will show us, even in the atmosphere of indoors, the wonder of opening Nature, often long before their outdoor cousins have dared to break their scaly shield.

As the leaf scales, the brown shields that form the spearhead, split apart, we see the brilliant green of the soft young leaves coming through, while the scales themselves bend backwards and downwards, and eventually fall to the ground, where they may stick by the score to the soles of our shoes as we walk beneath the trees. The young leaves are at first very soft and covered with hairs, and the several leaflets of which each one is composed are neatly folded, their edges being curled inwards, as shown in the photograph in page 272. The leaf stalk grows upwards, but the leaves themselves still hang, like half-closed umbrellas, the point where the leaflets join the stalk being the highest part of the leaf.

Later, as spring goes by, these leaflets open, spreading slowly outwards, and then gradually standing upwards, until the entire leaf, in all its palm-like beauty, is spread to the sun and the air. By now the whole tree is clothed in its rich, green summer coat, and by now, too, the

FAR-FAMED CHESTNUTS

Perhaps the most renowned horse chestnuts in Britain are those comprising the avenues at Bushey Park, adjoining Hampton Court. The occasion of their annual flowering is celebrated on "Chestnut Sunday," and great numbers of visitors from London are attracted to the park by the superb display of blossom.

H. Bastin

CHESTNUT CANDELABRA

The horse chestnut is, perhaps, our most beautiful flowering tree, so lovely are the spikes of pink, white, and orange flowers well set-off by the rich green of the great leaves. The projecting stamens hang like tongues from the mouth of each flower, their pollen falling inevitably on to the backs of nectar-seeking bees.

next and the greatest beauty of the chestnuts is prepared, a veritable feast of whiteness, before our eyes: the flowers are opening.

We can watch the gradual development and growth of the flower spikes on their stiff, strong stalks as easily as we have seen the gradual unfolding of the leaves, for they appear at the tops of the twigs and small branches as soon as the upper leaves have fallen apart. At first the spike is a pale brown, furry stem, bearing the flower buds as tiny balls of the same colour. The whole spike and the buds grow and the stalk pushes upwards, and growth may be extremely rapid if the season has been cold, followed by warmth and the encouragement of the spring rain. Whatever the weather, it is usually about the middle of May that we celebrate "Chestnut Sunday," an event of great importance in the birth of a new summer, and one that is eagerly awaited wherever the first blossoming of certain trees and flowers is looked upon as marking a conspicuous stage in Nature's calendar.

To see the chestnut at its best, one must have access to some wide parkland or to one of those great avenues, planted when men knew the value of trees, which are at once the ornament and the pride of many of our great country estates. Such an avenue is the famous one at Bushey Park, near Hampton Court, where the flowering of the chestnuts is an event of primary importance in the year. At blossom time in such a place as this the whole chestnut tree is transformed into a living castle of chequered white and green. At the end of every twig and branch there is a conical, candle-like spike of the flowers, white with reddish spots and orange-yellow markings. For a week, it may be, this lasts; then comes a day of wind, and the tree shakes itself, and the air is full of the dropping petals, falling like so many butterflies' wings to the grass of the park below.

In the summer the chestnut is at its least attractive, though even then, with the great spread of its fine leaves and the generous shade of its pyramid of foliage, it is one of the stateliest of our trees. The fruits, meanwhile, are ripening steadily. Though not so numerous as the flowers, for only the lower blooms on each spike bear fruit, they are none the less noticeable, and as summer turns into autumn we can see them all over the tree—round, green, spiny balls, which will soon drop and yield the schoolboy the final prize of "conkers."

In its fruit the chestnut again affords us a real beauty. As they ripen and drop to the ground, the green balls split open, revealing the nuts that charm the youthful heart. The green of the outer cover contrasts wonderfully with the fine reddish hue of the actual fruit,

E. J. Hosking

LEAVES OF YOUTH

Glorious as they are in summer, when their great fingers spread wide and give a welcome shade, the leaves of the horse chestnut are far more fascinating during the early days of spring, when they first open their cramped buds and slowly, carefully, unclasp themselves in the first warm rays of the sun.

lying in a soft, warm lining in a way that may remind us of a jewel in its silk-lined case; it is this fruit which has given us the colour, chestnut. The name, "conker," appears to be derived from the word conqueror, given to the nuts on account of the game, also known as "conkers," which is played with them. The best conkers are those which are picked up, smooth and ripe and shiny, after an autumn storm, but all too often the tree is raided by boys, whose bombardment of sticks and stones brings many fine specimens to a premature fall.

Chestnut's Pyramidal Shape

As the leaves fall, the tree is exposed to us in its winter nakedness, but now, too, it has a form that is pleasing and completely distinctive. The pyramidal outline is made the more noticeable by the fact that, in the parklands where the tree grows most frequently, the head of branches has a very characteristic flat base, often about six feet above the ground, where the lowest leaves and twigs have been eaten off by cattle. This low growth is not due to the branches coming from the main stem at any unusually low level, but to the fact, noted in the elm, that the branches bend downwards from a point many feet from the trunk. This can be well seen in winter, when we notice that the main trunk is thick and sturdy to a considerable height, with none of that very gentle taper found in many trees. The larger branches are often almost as big as this trunk, and the whole make-up of the tree is sturdy and strong. Lower branches often grow outwards for a little way, then curve gracefully downwards, so that the easiest way to climb this tree may be by catching hold of a small branch far from the main trunk, and swinging oneself upwards, rather than by tackling the smooth bole.

As regards the more particular description of the parts of the chestnut, it will be found that the bole of the tree is round, relatively thick in comparison to the height, which may, however, be as much as eighty to a hundred feet. The bark is greyish and rough, but with a rather flaky appearance; there is none of the deep grooving and furrowing that is found in most of the forest trees, such as the oak and the pine. The whole bole, may, however, have a decided twist, and this is especially evident in very large trees. If we come across a tree that has been blown down we often find a spiral splitting in the timber, although the bole is apparently straight outside.

Chestnut leaves are properly described as round, and cut into seven lobes, each of which is obovate in shape, having a serrated margin. The whole leaf may be as much as eighteen

E. J. Hosking

TOWER OF STRENGTH

Few trees have so great a weight of branches as the horse chestnut, and it is therefore not surprising to find that the bole of the tree is sturdy and straight. The rough bark is twisted with the tree's growth, and flakes that have peeled off can often be seen (as in this photograph) littering the ground below.

H. Bastin

'CONKER' SEED OF THE CHESTNUT

This series of pictures shows the way in which the seeds of the horse chestnut, the "conkers" that feature so largely in the pleasures of the autumn school-term, are arranged in their shell. The spiny exterior of the fruit contrasts strangely with the down-lined cells within, and the white and green of the shell help to show up the rich red of the nuts.

E. J. Hosking

'THE SPREADING CHESTNUT'

In winter, even more than in summer, we can appreciate the aptness of Longfellow's description, for the spreading nature of its branches is then the pre-eminent characteristic of the horse chestnut. Few trees are so symmetrical in outline as this, with its rounded crown and flattened base.

inches across, and when the weight, and resistance to the wind, of such a leaf are considered, we can easily understand the need for such stout twigs as the horse chestnut possesses. The flowers have a small, five-lobed calyx, with a corolla, also five-lobed, in which some of the lobes are rather larger than the others. The seven stamens are curved outwards and downwards, so that there is a space above them to enable a bee or other insect to reach the nectar within the flower. The upper petals have dots and specks of red and orange-yellow at their bases, an added guide and attraction for the inquiring insect. This arrangement, of course, is merely a means of ensuring that the bee shall arrive in the position best calculated to allow the pollen to be spread on its body. In this case the pollen would appear to be carried on the underside of the bee, not on the back or head as is the pollen of most flowers; in the chestnut the single, long pistil is carried in the midst of the stamens, so that any pollen on the bee's underside will fall off on to it.

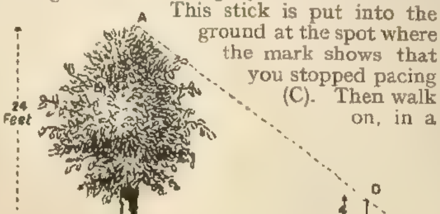
THE ovary, which later enlarges to become the green, spiny fruit that contains the "conkers," is in three parts, and when ripe it splits into three. If there is one fruit it may be perfectly round, but more usually we find that one or two sides are flattened by the presence of the fruits in the other cells. These fruits are not eaten by horses, but cattle and sheep and deer will all devour them with avidity. The name horse chestnut was said by Evelyn to be derived from the use to which the fruits were put, in eastern parts, for curing horses of coughs and breathing troubles. Since, however, horses refuse to touch the fruit, there seems little doubt that this explanation is erroneous, and it is more probable that the name is used in contrast to the sweet, or edible chestnut; compare the *dog* rose and *dog* violet, both of which are scentless.

The tree is not a native of this country, having been introduced about 1550. The timber is extremely soft—almost alarmingly so when one first comes to cut a branch of chestnut with an axe—and is of little commercial value. It will, however, take a fine polish, being very close-grained, and is useful for cabinet-making and for flooring. The twigs are also said to make extremely fine charcoal, being valued for that purpose in gunpowder mills in former days. A characteristic of these twigs in winter is the very distinct horseshoe-shaped mark below each bud, showing where the previous year's leaf has fallen off. In parks and gardens one may sometimes see a variety of the tree, the red-flowered horse chestnut, whose name is self-explanatory. A smaller and more delicate tree, it is not found in the wild state, and is probably a garden hybrid.

HOW TO TELL A TREE'S HEIGHT

Next to its age, the most fascinating question about a tree is, "What is its height?" When the tree is deep in the heart of a wood it is extremely hard to get any accurate idea of how high it is, but out in the open there is ample opportunity. The method described here and illustrated in the accompanying diagram, may be adopted in any situation in which there is a clear view of the tree from one side at least and where the ground is level.

Stand at the base of the tree (B) and pace a regular distance away from it in a straight line, say, ten to twenty good paces, and mark the spot where you stop. Cut a stick, four feet long or, if possible, a little more, so that when it is stuck into the ground four feet project above the soil. This stick is put into the ground at the spot where the mark shows that you stopped pacing (C). Then walk on, in a straight line with the stick and the tree, for a few paces; lie down from time to time until you come to a point at which, with your eye at ground level, you see the top of the tree and the top of the stick coincide. At this spot make another mark (E). You now have two imaginary triangles, as shown in the diagram, and the proportion of the side CD to the side CE, in the smaller triangle CDE, is exactly the same as the proportion of the side BA to the side BE, in the larger triangle BAE. Say, the stick is 4 feet high, and line CE is 6 feet, and the total length of BE is 36 feet. Then 6 is to 4 as 36 is to BA: that is to say, BA (the height of the tree) is 24 feet.



Eric Hosking

CHESTNUT GLORY

When loaded with its candle-like blossoms, the horse chestnut makes an exceedingly impressive and beautiful spectacle. During the period of its flowering, indeed, it is perhaps the handsomest of the arboreal range and it is not to be wondered at that crowds of townsfolk—and country-dwellers, too, for that matter—make pilgrimage to those places where its full glory is particularly made manifest

Newman

STOAT FORTRESS

Among the most favoured habitats of the stoat are holes in decrepit walls, broken ground, and rugged rock-faces. The pair seen in this photograph are fortunate in having discovered a cleft in the hill-side and appropriated it as their headquarters

O. G. Pike

PRIDE OF POSSESSION

Strong, upright, and yet with a certain graceful beauty, this hen curlew is a fine example of a proud parent of the moorlands. She is just preparing to settle once more on to her four eggs ensconced in their roughly-constructed nest

Taylor

GLACIATED GLENCROE

The Argyllshire pass of Glencroe is one of the beauty spots of the Highlands, but few of those who appreciate its grandeur think of the glacier which, in days immensely remote, rounded its sides and smoothed its floor

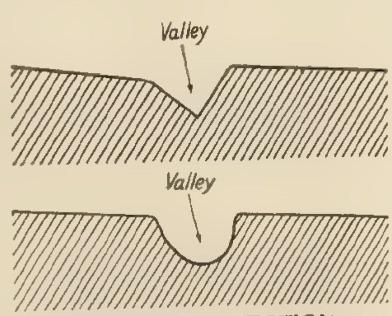
REMAINING RELICS OF BRITAIN'S ICE AGE

Tens of thousands of years ago the greater part of Britain was covered, not once but several times, by a vast ice sheet, and in the chapter that follows are listed the concrete evidences of the long-continued and successive glaciations. It is hard to realize the conditions prevailing in those days, but it is more than a hypothesis that men—some kind of men—managed to adjust themselves to a tremendously changed environment

In the period which succeeded the tertiary era, and which is known as the *pleistocene* period, Europe suffered from a spell of intense cold, or, to be more exact, four periods of intense cold interspersed with warmer intervals. These four periods are classed together as the "Great Ice Age," and during them Europe experienced Arctic conditions. Ice fields covered Scandinavia, much of Germany, France and Belgium, and extended in Britain from the north down to a line drawn from Bristol to the mouth of the Thames.

There were several ice caps, or centres of glaciation, that affected the British Isles; some of the ice came from as far away as Scandinavia, as is proved by the presence on our east coast of glaciated boulders which can have originated only in that district. Other ice caps existed in the north-west Highlands, the Grampians, the southern uplands, the Lake District, the Pennine Chain, and in Ireland and Wales. It is not surprising, therefore, that abundant evidence of our frigid past is presented in the scenery of the British Isles.

A glacier is simply a mass of ice, formed high up in the hills and compacted by the weight of the snow that falls upon it, which is turned to ice in its turn. The gradual accumulation of ice and snow forces the glacier to descend farther down the valley, scouring the ground over which it passes and carrying the débris downhill, until, in the course of time, it is brought to the end of the glacier, where it is dropped by the melting ice. The accumulation of material at the end of a glacier is known as a *moraine*, and the great mounds of débris standing in the valleys of regions that have suffered glaciation in the past are old moraines, left there when the glaciers melted away.



VALLEYS IN SECTION

Top, typical V-shaped cross-section across a river valley contrasted with (below) the U-shaped cross-section of a glacial valley. An actual example of a glaciated valley is pictured opposite.

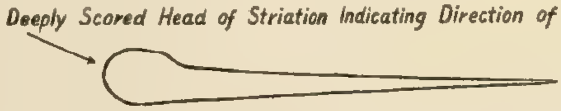
These glacial deposits are easy to recognize. Although of sedimentary origin, they are unstratified, since they were deposited on a land surface and have had no weight of overlying deposits to compress them; and the most common form of deposit is that of boulder clay, a stiff clay containing numerous stones and boulders, often interspersed with sands and gravels where rivers alternated with glaciers. Boulder clay may be found in many of the valleys of Scotland, Ireland, Wales and the north of England, and its presence is a certain indication that those parts of the land were once an ice-covered wilderness.

But boulder clay is not the only evidence of glaciation. A ramble in almost any of the more rugged parts of the British Isles will give ample opportunity to the field geologist to collect the evidence for himself. Great boulders of rock, "perched blocks" as they are called, may be seen, for instance, balanced precariously on hill-slope and mountainside. So large are some of these boulders that they could have been transported by no natural agency save that of ice, though there are attractive myths and legends that tell how the great rocks were left there by the careless hand of some long-dead giant.

Additional proof of glaciation will be revealed by an examination of the surface of some boulders; long scratches will be seen, most of them running parallel to each other and with a deep indentation at one end. These *striations* are indications of the glacier's work having been caused by the moving ice as it passed over the boulder's surface, dragging pebbles and other rock fragment with it on its passage.

Similar striations may be seen on the surrounding rocks of the countryside, and they show clearly the direction that the glaciers took, since the length of the striation is always parallel to the line in which the ice moved,

Deeply Scored Head of Striation Indicating Direction of Ice-Flow



while the deep indentation is the mark at the *end* of the scratch, pointing definitely to the direction in which the ice flowed. Often one comes across smoothly-polished surfaces covered with such striations, and these are known as *glacial pavements*; or, again, one may see rounded hummocks of stone similarly striated. These hummocks are very common in Wales and Scotland, where they form a well-known feature of the countryside; to geologists they are known by the name of *roches moutonnées*.

Glaciation is also evident in our landscape as a whole, for the great, slow-moving rivers of ice carved out their own valleys long ages ago. The first difference between glaciated and non-glaciated country is shown in the shape of the valleys. Rivers carved a V-shaped valley, but glaciers cut out a valley of U-shaped section with a broad, flat bottom and steep, precipitous sides. Such glacial valleys may be readily distinguished in many parts of Scotland, Wales and the north of England, for all exhibit a characteristic scenic feature in that, if viewed from below,

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GLACIER-ROUNDED HILLS

The effects of glacial action are not confined to the most mountainous districts of the British Isles. This panorama over the Lowther hills in Scotland shows how glaciers have had their effect in carving the hills and hollowing the valleys.

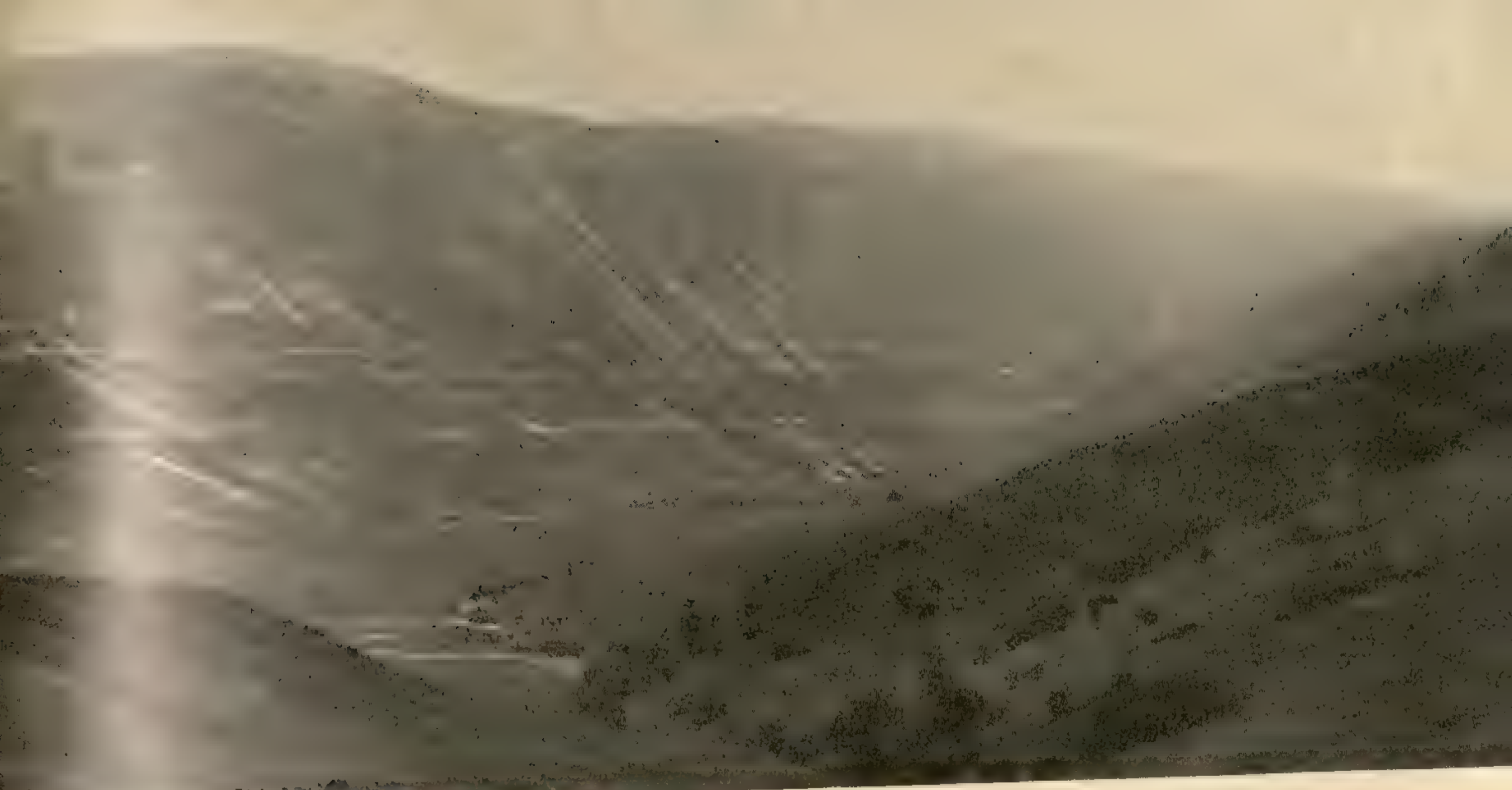
they appear to become increasingly rough and rocky as the eye travels upwards, while a bird's-eye view reveals a smooth surface below. This phenomenon is common in Britain and is most usually associated with landscape sculpture of the ice age.

When the climate changed and the glaciers melted away, great lakes filled the valleys, since their exits were blocked by accumulations of boulder clay. Much of this moraine material has been worn away by erosion and many of the lakes have disappeared, but there remain quite sufficient glacial relics to enable one to reconstruct the glacial distribution of the past. Besides moraines there are other deposits of boulder clay which have a different origin to the moraines; some occur in large sheets and are supposed to have been laid down by sea ice or drifting bergs; others occur in mounds and were deposited by the glaciers en route; many of our northern valleys contain series of lenticular-shaped mounds of clay known as *drumlins*, and the

CARVED BY THE ICE

In many highland districts corries, or small valleys in the flanks of the mountains, are common features. These corries, which are mostly of circular shape, once contained small glaciers which poured their ice into the main valley. This picture shows such a corrie near Applecross in Ross-shire.

H. F. Taylor



Valentine

HIGH-WATER MARKS

In certain of Britain's valleys parallel lines scar the hillsides, indicating the changing levels of a now vanished lake, the exit of which was once blocked by ice. When the ice melted, the waters drained away. This picture shows the famous "roads" of Glen Roy.

direction of their long axes gives an indication of the direction in which the glaciers moved.

The glacial origin of many of our lakes in the north and west is proved by the soundings that have been taken, for a glacier-formed lake is deeper at the upper end, where it has been hollowed out by the inflowing masses of ice, whereas the majority of lakes are deeper in the centre.

Sometimes rivers were blocked by glaciers creeping across their path and forming a dam, thus holding back the waters in a temporary lake. When this occurred a temporary level in the lake waters was established and a terrace was cut in the hillside. If, for some reason, the level of the water changed, another terrace would be formed at the new level, sometimes a succession of such terraces being cut. An excellent example of such terracing due to glacial action occurs in Glen Roy in Inverness, where parallel "roads," or terraces, flank the hillside.

The rivers of glaciated country often show interesting features. They first began to cut their way through the

THE GLACIER'S END

When the glaciers receded they left large mounds of boulder clay and other débris—moraines, as they are called—to mark their passing. Even now some of the moraines are instrumental in damming the waters of a lake, as may be seen in this picture of Ross-shire country.

Geological Survey

I. Beattie

STRANDED BOULDERS

Glaciers are capable of carrying vast masses of material for many miles. This picture of Loch Coruisk, Isle of Skye, shows some of the perched blocks, or "erratics," which owe their present position to transport by ice.

soft boulder clay which filled the valleys; then as they eroded their channel, deepening it, they came to harder rock beneath it, in which they proceeded to cut their channel. Subsequent erosion and weathering have often removed much of the boulder clay, and in so doing revealed an older channel, where once the waters of a pre-glacial river ran.

Such an example of an additional river course, or superimposed draining due to interference in the river's course by glacial deposits, is seen at Runcorn gap, where the Mersey has carved out a channel through deposits of boulder clay, while the old and much deeper pre-glacial course of the river passes under Widnes.

So much evidence of the Arctic past is to be found that the "Great Ice Age" is one of those facts which has raised little controversy. The details of Britain's glaciation are of interest mainly to geologists who have made a long study of them, but the cause of this climatic change, which is of interest to all, is still obscure. Was the glaciation due to a lowering of the earth's temperature, a shifting of the Poles, the movement of the land-masses themselves, or the elevation and subsidence of the land with the consequent raising or lowering of the temperature relative to the increase or decrease in height above sea level? Perhaps the earth shifted on its axes, or the warm currents in the seas altered their direction. As yet we cannot say.

Geological Survey

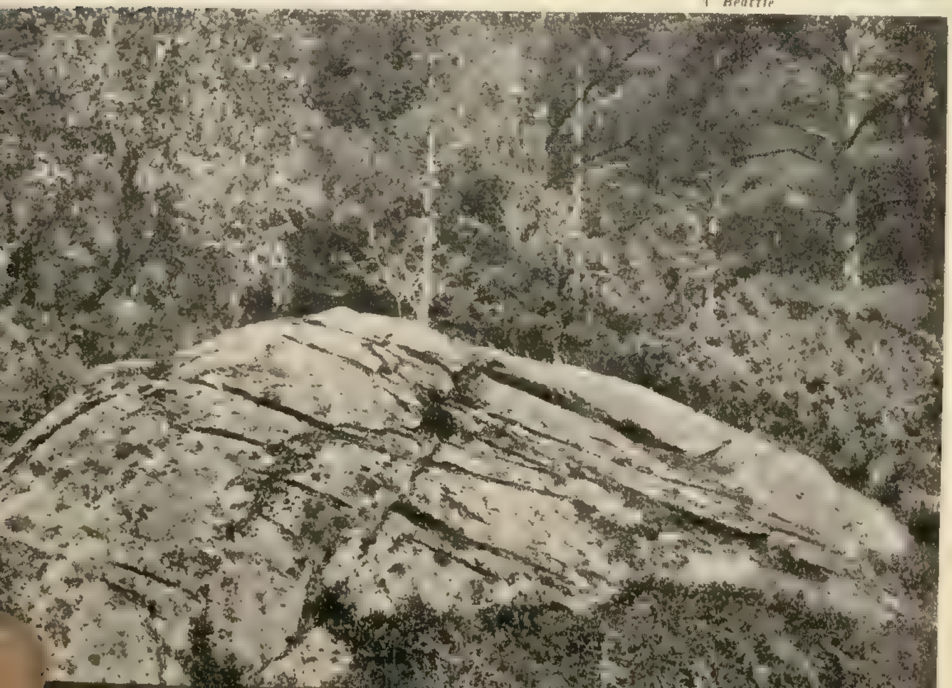
GLACIAL STRIATIONS

Glaciers have left behind them many signs of their past activity. This photograph shows how a passing glacier has smoothed and scratched this rock "pavement" at Harrington, in Cumberland.

PREHISTORIC SCRATCHES

This photograph, taken in Inverness-shire, shows the typical rounded form of a boulder over which ice has passed. Such *roches moutonnées* are typical of glaciated areas. The parallel lines indicating the glacier's direction are clearly shown.

I. Beattie



HERMAPHRODITES OF THE GARDEN UNDERWORLD

In the first chapter included under this heading (see page 128) some of the most important features of the earthworm were revealed. Now we have a detailed account of one particular department of the lowly creature's life. As told below, the mating procedure of the earthworm makes a story as fascinating as it is novel

It often happens that in order to find the origin of a term used by naturalists, we must turn to the old stories of Greek mythology. "Hermaphrodite" is a case in point. Hermes and Aphrodite, we are told, had a son whom they called, by combining their names, Hermaphroditus. The nymph who presided over the fountain of Salmacis in Caria fell in love with the youth, and the two united to form a being which had the characteristics of both sexes. When naturalists sought for a word which would describe certain animals found to possess both male and female characteristics in one individual, they lighted upon the name of this strange composite being and included it in the scientific vocabulary—although it seems extraordinarily incongruous when used to describe such a particularly unromantic animal as the common earthworm.

Earthworms are hermaphroditic inasmuch as each individual contains both the male and female organs of reproduction. Many people believe, when they find an earthworm after turning over the ground in the garden with a fork, that the red thickened portion of its body is the part where, after the worm has once been cut in half by a spade, the two pieces thus formed have joined together again. There is, however, nothing so extraordinary about this thick red portion of the worm's anatomy, and if a worm is cut in half anywhere below its gizzard it will either die or go on living with only half of its intestine in working order.

Generation Among the Worms

The red portion of the worm, which, unlike the rest of the body, is not segmented, contains the female sexual part, while the male organs are situated nearer the head and have no distinctive characters on the outside to show where they may be found. In a true state of hermaphroditism, such as is to be seen in some of the parasitic worms like the tapeworm and liver-fluke, a single individual is able to fertilize itself and thus produce a large number of ripe eggs, and so multiply its species. Taking these facts into account, the common earthworm is obviously not a true hermaphrodite, for one individual is incapable of reproducing its species without the help of another.

Worms have no definite mating season, but the process is usually carried out during the warm days of the very early spring. Looking out of the window on to the lawn in the early morning, one may often see a number of worms lying about on the grass. On closer examination it will be found that these worms are grouped together in pairs, one worm coming from one hole and the other from another, and that they are joined by mucous bands along the front of their bodies, their tails remaining firmly embedded in the mouths of their burrows. If they are approached without due care, the mere vibration in the ground caused by a heavy footfall will immediately disturb them and, letting one another go, they will vanish from sight, each down its own hole.

Actually, the process of reproduction takes place by an exchange of male "gametes" or sperm. While the worms are so firmly clasped together this exchange of gametes is being carried out, each worm in reality acting as both male and female. The male gametes from the one worm are collected in the other in a special series of receptacles known as spermathecae, where they are stored until the eggs which are to be found in the broad, reddened portion of the body are ready to be liberated. After a time the worms come apart, but although both are well supplied with sperm, fertilization does not take place at once.

Eventually the worm feels an impelling urge to relieve itself of the eggs which have been rapidly growing,

EARTHY COURTSHIP

Although worms are in a sense hermaphroditic, reproduction requires the conjunction of two individuals. In this photograph two worms, their tails firmly fixed in their respective burrows, are engaging in the preliminary courtship.

J. J. Ward

and it is now that the red portion of the body plays its all-important part. It is composed of a large number of glands situated near the surface of the skin and connected with the outside by a series of ducts. By means of these ducts a mucous secretion is allowed to flow from the glands on to the outside of the skin, and as soon as this comes in contact with the open air it solidifies into the form of an elastic ring surrounding the body of the worm.

Fertilization of the Eggs

THE worm having come to the surface in order to complete the final stage in the process of reproduction and the elastic ring having already been formed, the eggs are liberated by way of another duct, so that they lie between the elastic ring and the body of the animal. The worm now begins to wriggle with a regular motion, and the ring passes slowly along its body towards its head, carrying the eggs with it. As this passes over the duct leading to the spermathecae where the sperm from the other worm have been stored, these sperm are liberated into a tiny duct and pass into the space between the ring and the worm's skin, into which the eggs have already been secreted.

WORM WEDLOCK

The drawing above on the left gives an impression of two worms which have come together, thus permitting the male part of one to transmit sperm to the female part of the other and vice versa. The photograph on the right shows a mature worm before mating – the red, unsegmented portion of the body being somewhat enlarged.

The worm continues the wriggling motion until completely free of the ring, which, as soon as it passes over the head and is clear of the worm's body, closes at both ends to form a neat, watertight capsule, in which both eggs and sperm are carefully stored. It is now that the actual process of fertilization takes place. The sperm swimming about in the fluid into which they have been released find their way to the ova and, impregnating them, set in motion the complicated process of division and multiplication of the cells which, in the course of development, gives rise to the young worm.

Each "cocoon," as the egg-capsule is called, contains three to four eggs or ova, all of which are fertilized. In most species, however, only one of these reaches maturity, the others dying off or being absorbed as nourishment by the surviving embryo.

While this is going on, however, the capsule containing the developing egg is soon washed into the soil by the rain, and when, finally, after some weeks, it breaks open, the liberated baby worm finds itself deeply buried in the ground.

Careful dissection of a dead earthworm will reveal all the various reproductive organs neatly enclosed within the body, the spermathecae appearing as small, white sacs lying in the ninth and tenth segments.

F. W. Bond

CLOSE-UP VIEW

In this picture of a worm (about twice life-size) the band of sexual, glandular tissue, so often thought to be a scar, can be seen at the bottom of the photograph a little way from the "head." Because the worm had just completed the process of mating when the picture was taken, this appears not as an enlarged portion but as a sudden thinning of the body.

INSPIRING SINGERS OF THE AVIAN CHOIR

Although to outward seeming the skylark and the curlew—the two birds described in the chapter that follows—have not much in common, the magic of their song serves as a link to justify their combined treatment. The peculiar qualities of their outpourings are described below, and many other details are mentioned by which the one bird and the other may be readily identified

When there is talk among bird-lovers of the relative beauties of the songs of different birds, and when decisions are being made as to which is the favourite song, the skylark is always sure of at least an "honourable mention."

Some may prefer the flute-like notes of the blackbird; others will vote for the nightingale; others, again, find their greatest pleasure in the sweet music of the willow warbler; but perhaps the most fortunate are those to whom the skylark conveys the feelings which seem to inspire its song. On and on, up and up, swings the lark, pouring into the heavens an undying paean of praise, of joy in living, of sheer, perfect happiness, such as no other bird can approach, let alone surpass. Musically, perhaps, this is no great song, challenging no comparison with the blackbird's tenor or the songs of even the lesser warblers; but, nevertheless, it is in a class by itself, for the lark is the bird that sings from its heart.

Nothing in the appearance of the skylark suggests the power and exaltation of its song. It is a plain, neat, brownish bird, with little that will help to distinguish it from its near relatives, the pipits. The brown of the back and upper parts generally is streaked with black, and there is a pale stripe over the eye. Underneath, the general colour is whitish-buff, with a few spots and markings of brown on the breast. The tail, which is fairly long, is slightly forked, a point that serves to distinguish the bird from the closely-related woodlark, and the feathers of the wings and tail are more greyish than brown. The legs are dark, and an important characteristic is the very long hind toe, a feature found in all the larks and in some of the wagtails and pipits. On the head there is a small crest, which is most noticeable in the male; this helps to differentiate the bird from the meadow pipit, described in page 72. The beak of the lark is another point of interest, for it is midway between the short, strong beak of the finches and the slighter, longer beak of the pipits and wagtails; the larks, as a matter of fact, are placed by systematic ornithologists between these two in point of classification. We have, besides the skylark, one other species, the woodlark, breeding in the British Isles; while the handsome shore lark is a regular passage migrant.

The skylark's nest is a shallow cup of grass, lined with similar but even finer materials, and it is always on the ground. Sometimes the bird will build on the bare, flat surface; at other times it will scrape a little hollow, seek the shelter of a tuft of bents, or even use the hole made by some object that has been in the soft earth—the hoof-marks of horses and cattle are very favourite sites in fields that are damp or clayey. The eggs are from three to five in number, and they are so thickly mottled with dark greyish-brown as to appear entirely brown in colour. The first clutch is laid in April, and there is usually a second brood.

Although, in thé south of England at least, the skylark is a common bird throughout the year, those which we see in winter are probably different from the summer

DISAPPOINTMENT IN STORE

Three hungry youngsters greet the hen skylark on her return, but her bill is apparently empty of food, and it looks as if they will be disappointed. The bird's striped plumage blends almost as admirably with the background as does that of her progeny.

Ian M. Thomson

Ian M. Thomson

BABY LARKS ASLEEP

Tightly bunched together in their nest, these sleeping baby skylarks are amply protected by the resemblance of their coats of curious, long hairy down to the surrounding grasses. This photograph compares amusingly with that opposite, taken when the babies had awakened at meal-time.

birds, for the lark is one of our most regular migrants, both in spring and autumn. Large numbers of larks are among the first birds to arrive, and equally large flocks leave our shores every year as the winter approaches. It is not certain, however, that those which leave us in the autumn are birds that have bred here ; and the whole problem is immensely complex. The skylark, in fact, seems to be present in this country as a resident, a summer and winter visitor, and a passage migrant, and it has been the subject of much careful research into the mysteries of migration. As an instance of the wide range of the bird, besides the birds which move to and fro within the country and those which arrive and leave at the various seasons of migration, we have larks that pass through from Central Europe and others that come from the Scandinavian countries in the autumn. Some flocks travel slowly down the coasts of the east or west ; others pass rapidly through the country ; others, again, appear to be true residents.

The skylark is essentially a bird of the open, and is at its best in a wide, flat country where there are plenty of fields and no trees. On the downs and the dry moorlands it is equally at home, and it is seen as often on the wet, lush river meadows as among the allotments on the borders of some great industrial town. Few birds, in fact, are found so near the haunts of Man and at the same time so far from all his works, and few give such pleasure wherever they are. In so far as its food is concerned, the lark eats insects and seeds, and in the spring it may cause a certain amount of damage by devouring the tender shoots of corn and other green plants that are just showing through the soft soil ; but, on the whole, it does far more good than harm and may be accounted one of the farmer's friends in spite of its occasional lapses.

It may seem strange to link in any way with the skylark so wild and distantly related a bird as the curlew, but the two birds have one great point of common appeal, and that is their song. To those who have never heard the curlew's spring song, this statement may seem surprising, but to anyone, whether interested in birds or not,

OFF DUTY

Even when she is roused, the curlew makes no fuss about leaving the nest, but slips quietly away and only takes to the wing when some distance from her eggs. Here she is walking away for a rest, unalarmed by the presence of the photographer in his near-by hide.

S. Crook

it must come as a shock, not only the first time it is heard, but whenever it strikes the ear. The similarity in the songs of the skylark and the curlew consists rather in effect than in construction or musical quality. The skylark's is the epitome of happiness—unbridled, perhaps; inspired, certainly—and it is this same quality of inspiration that marks off the spring song of the curlew from almost every other bird sound.

Magical Song of the Curlew

To hear this song we must get away to the far and desolate moorlands, the upland marshes or the distant peat-bogs where the bird breeds. We may very occasionally find the bird nesting in estuarine flats or on the pastures of the higher farms, but it is among the far-distant moors, where its sole company is the grouse and the merlin, that the curlew has its home. There, in the spring, we may hear the magical song. The male bird leaves the ground and starts a long, dancing flight, rising and falling, sweeping to and fro, beating with rapid wings down to the surface of the moor, sheering steeply upwards against the sky line, and then, as suddenly as this nuptial flight began, the song begins, too.

Just a series of long, wavering notes, the song owes its quality, not to the mere sound, but to the whole manner of the performance. The great, bare, bleak hillside, the wide expanse of sky, the very desolation of the high moorland, all create an atmosphere of which this song is essentially part. The notes have a quality that is best described as thrilling, and the way in which they fall and rise again and almost cease as the bird wheels away, and then return as he sails back on the wind, adds enchantment. No one hearing this song can stay and be wholly unmoved. It invites, and by its very weirdness challenges, one to be up and follow the bird, follow it over moors and mountains, away to a distant country where the spring is everlasting. Many other birds nearly related to the curlew have songs that are basically similar, but not one of them sings with the same almost supernatural power of being able to disturb and attract the most hardened townsman. It is enough, when the curlew are mating, to lie in the heather and listen while they sing, and then rise and return home, bearing with one the memory of an experience that is totally unforgettable. To many people the curlew's may seem a mournful song, but it is worthy of note in this connexion that to so great an authority as Lord Grey of Fallodon it suggested "peace, healing and joy."

A MEMBER of the same group as the green plover and the common snipe, described in pages 257-260, the curlew is very different from either in appearance. It is a fine bird, upright in carriage and strong in flight, its long, narrow, sharply-angled wings closely resembling those of the gulls. The bill is immensely long and curved downwards, a feature that is of great value when the bird is feeding in the bogs of the moors or among the estuarine mud flats which it haunts in winter. The curlew also eats insects and berries in its moorland home.

The general colour of the bird is a rich brown, not very dark, but streaked with darker colours on the upper parts. The feathers are edged with buff, which is the general colour of the underparts. The wings are darker, and so is the tail, and the chin, abdomen and under tail coverts are whitish. There is a pale eye-stripe. The length of the bird is 23 inches, and the wing span is well over two feet. The eggs, four in number, are pale buff, with darker markings and streaks about the larger end, and they are placed in a mere hollow scraped under a tuft of bents or among the tussocks of long grasses.

Curlews will defend their nest against marauding crows or other birds, and on the approach of mankind the male

Ian M. Thomson

THE BABIES AWAKE

Alighting gently on the grass above the nest, this cock skylark brings a beakful of luscious grubs for the anxious youngsters in the nest. The upturned faces and open mouths of the brood show how welcome is the meal. Notice the characteristic crest on the father's crown.

Ian M. Thomson

SITTING TIGHT

The curlew provides an example of a bird that profits by sitting very close on its eggs, for its plumage harmonizes excellently with the background. The long, curved bill and the streaked markings of the plumage are shown admirably in the above photograph.

warns the female with the characteristic cry, *cur-li*, from which the bird gets its name. The hen slips quietly off the nest, and if we go to seek the eggs in the direction from which we ultimately see her rise, we shall fall into the trap and be completely misled. When the young are about, the parent birds keep up a continuous calling (often written as *whoo-wee*) so long as the intruder is in sight. On a walk across the moors where curlew are plentiful we may be followed all day by a chorus of these alarm notes, as pair after pair of the birds get up and utter their warning cry.

Fond of the company of its fellows, the curlew moves in winter down to the mud flats of the estuaries, where enormous flocks assemble and make the winter air pleasant with their calls. They are readily distinguishable, by their size alone, from the other birds on these popular feeding grounds, and they are also very easy to approach. As the birds get up and flit away a few yards to a new patch of mud, we see the light colour of their underparts, and the fine shape of their strong wings is silhouetted against the sky as they stretch and preen themselves. The curlew can swim, too, and feeds often when the tide is coming in and there are several inches of water over the mud. Sometimes in the night we may awake and hear, high overhead, the faint *cur-li, cur-li*, of the migrating birds, but even though it be moonlight they will most probably be far out of sight, for not only do they travel fast and far, but often fly very high.

MATERNAL CARE

Fearing for the safety of her chick, this hen curlew has called the little one near and is now raising herself on her wings to shield it. The young bird can be seen crouching under its mother's breast, while just in front is the broken egg-shell from which the chick was hatched.

ANEMONE SIRENS OF THE SEASHORE POOLS

So bewitchingly beautiful, as every visitor to the seaside will readily allow, yet the sea-anemone's beauty is a monster's mask. Let an unwary fish come within reach of the gently-swaying tentacles—the mask is thrown aside, and the demon of the pool is revealed in all its seductive horror. These lovely death-traps are described and pictured below, and reference is made to other, less dreadful aspects of their life

The rocky pools along our coasts hold a varied and fascinating store of life, which is a constant treasure-house of material for all who seek to probe the secrets of Nature. Some of the commonest inhabitants of this strange world between the tides are the sea-anemones, and everyone who has walked over the weed-covered rocks and boulders, searching the pools for fresh wonders, must be familiar with their appearance. When the tide has receded and they are left stranded on the uncovered rocks, they appear as limp, tubular blobs of jelly-like material, coloured most usually a dull red or green; but when they are found in the pools with their long, sinuous tentacles extended, and their colouring enhanced by the sea-water, then these flower-like creatures reveal the full measure of their beauty.

Sea-anemones are not, as some people believe, plants; they are lowly forms of animal life only a little higher than the sponges, and related to the freshwater hydra, the marine hydrozoa and the jelly-fish, together with which they are classed as the *Coelenterata* (Gr. *koilos*, hollow; *enteron*, intestine). Enchanting as is the appearance of the anemones, those pools which are transformed into fairylands of wonder by the miniature forests of their tentacles, red, brown, green, orange, white or mauve, gently waving as they move with the ebb and flow of the tide, are death-traps to the smaller forms of marine life.

For these lovely sea-creatures are omnivorous feeders, preying voraciously upon small fish and crustacea which come within their grasp, enwrapping them with their delicate tentacles. In order to aid in the capture of the prey these tentacles are armed with *nematocysts* (Gr. *nema*, thread; *kystis*, bag), or stings, which paralyse the unfortunate victim and render its struggles ineffective. Those who have seen a small fish caught in the relentless grasp of this seductive monster must have been filled with pity as its struggles gradually weaken before it is sucked into the gluttonous mouth of the sea-anemone. Small fish, shrimps, water fleas and all manner of the lesser forms of marine life are thus devoured when they fall foul of those sinuous tentacles, and only the inedible skeleton or covering is ejected by the gaping orifice to mark the tragedy. One can test the strength of the tentacles for oneself by placing a finger within their grasp and feeling the steady drag as they attempt to pull the finger into the body cavity. Luckily, the stinging organs of the sea-anemone, unlike those of the jelly-fish, are not sufficiently powerful to penetrate the human skin.

Apart from the activity of its tentacles, the sea-anemone is a sluggish creature, consisting mainly of a long tubular body. These coelenterates are capable of moving from their position on the rocks, but only with great difficulty and by strenuous contortions; to all intents and purposes they are sedentary.

LOVELY BUT GREEDY

The vestlet anemone is one of the most graceful ornaments of the sea pool; with its long stalk and its delicate tentacles that move languidly in the water it might well stir the poetic fancy, but its beauty only cloaks a prodigious appetite. (About natural size.)

W. S. Berridge

W. S. Berridge

QUAINT COOPERATION

This photograph shows an anemone (*Adamsia*) and a hermit crab living together for their mutual advantage. The anemone affords protection to the hermit crab by scaring away menacing fish, and in return enjoys scraps from the crab's meal and also the benefit of a continual change of feeding ground (actual size).

Reproduction in the sea-anemones, unlike that of some other animals within the group, is simple and uncomplicated by different larval stages or alternation of generations. The sea-anemones produce individuals which are sexually distinct, the reproductive organs forming within the body wall. In the male the sperm are liberated into the body cavity and swim out through the mouth and into the body cavity of the female, where they fertilize the ova. The eggs develop within the female and are finally liberated as free-moving planular larvae, which swim through the water for a period before settling down, attaching themselves to a piece of rock by their broader end, gradually undergoing transformation until they mature into fresh sea-anemones.

The sea-anemone sometimes develops strange habits when spurred on by the struggle for existence, and some forms illustrate very well the phenomenon known to biologists as *commensalism* (Latin, *com-*, with; *mensa*, table), that is, the state when two different animals associate for their mutual advantage. Certain sea-anemones are found on top of whelk shells that are occupied by hermit crabs, and the association is formed in the following way. The hermit crab is a very timid fellow, peculiarly solicitous about his weak, vulnerable hinder part. In order to ensure increased protection from attack by animals that might seek to drag him from his stolen abode, he places a sea-anemone upon the outside of the shell to frighten away marauding fish by the threat of its stinging tentacles. The anemone obtains benefit from this partnership by sharing in the hermit crab's meals and obtaining free transport. When the hermit crab outgrows its shell and is forced to take a fresh one, it removes the anemone—which, though capable of moving slowly over short distances, is unable to cover by itself the distance needed to continue the partnership—and places it on top of the new home. It is remarkable that the sea-anemone should allow itself to be thus transplanted by the rough claws of the crab, for it will shrink into itself and cling closer to the rock at the slightest touch of soft, human fingers.

There is one anemone that cannot retract its tentacles in this way, and this is also the partner in a strange association, though one that is not of so close a nature as that just described. This anemone is the partner with another member of the crab family, the spider crab. A timid creature, the spider crab seeks to conceal himself beneath pieces of seaweed, stones and other objects with which he can cover himself, and he is often found hiding beneath the long tentacles of the sea-anemone. When a morsel of food floats through the water, he will

PARTNER OF THE CRAB

Sagartia is another anemone which is frequently found living a commensal life, though the other partner in this case is the ordinary crab. The anemone is carried about in the claw of the crab. The benefits derived from the association are the same as in the case of the anemone and the hermit crab (actual size).

Crawford

GRACEFUL TENTACLES

Anemonia sulcata is one of our common anemones. Unlike the majority of its kind, it is unable to retract its tentacles, and always remains open. The picture above shows what an underwater fairyland can be created by these animals. (About ¾ life-size.)

UNDERWATER GARDEN

[illegible] photograph below is of a submarine garden containing several [illegible] creatures. At the top of the picture may be seen the sulcata [illegible], while in the foreground are some beautiful plumose [illegible]. A branching coral completes the scene. (About ¼ life-size.)

[illegible] *Kingston*

Crawford

UBIQUITOUS ANEMONE

The beadlet anemone is one of the commonest inhabitants of our sea pools, and brown, green or red individuals occur on almost all our rocky shores. No visitor to the seaside can fail to come across examples of this anemone (about ⅔ life-size).

sidle out from under cover and seize it, retiring again quickly to the protective shelter of the tentacles. The anemone then reaches out and usually succeeds in wrenching the prize from the bewildered crab. But after the anemone has finished digesting its meal it throws up the remains and a thin film of undigested matter, which falls to the lot of the waiting crab. Thus the spider crab is forced to sacrifice good living to safety.

There are many different sea-anemones to be found off the coasts of the British Isles, and though none are so brilliant in colour or of such large size as some of those that live in tropical waters, there are many beautiful examples, one of the loveliest being the plumose anemone, which has a longer body than is ordinarily found among the sea-anemone tribe, and tentacles of a feathery appearance. These exquisite inhabitants of the shallows seem too ethereal to cause harm, but their appearance is deceptive, because, as elsewhere in Nature,

Bond

BELLES OF THE POOL

The plumose anemone is a reward in itself to those who find it in our sea pools. Its beautiful pale tints and the feathery appearance of its tentacles mark it as exceptional amongst its kind. It is fairly common in Devon and Cornwall (about ⅓ life-size).

behind loveliness lurks death; what may please the eye of the aesthete may be death to the prawn, just as a gorgeous sunrise may herald the coming of a tremendous and destructive storm.

Revealers of Nature. 9

LORD AVEBURY

It is not often that a business man—a banker and politician—leaves a reputation for literary genius and scientific acumen to perpetuate his name, or becomes equally famous in his own generation as an anthropologist and a naturalist, and as the chief sponsor of such Acts of Parliament as the Bank Holidays Act and the Shop Hours Act. Yet Sir John Lubbock, first Baron Avebury, not only initiated important social reforms both as a banker and a Member of Parliament, but also wrote one of the most famous studies in natural history—his book, "Ants, Bees and Wasps," published in 1882; he was president of both the Institute of Bankers and the British Association, and combined the duties of chairman of the London County Council and chancellor of London University. During the thirty years (1870–1900) which he spent in the House of Commons, as well as during his membership of the House of Lords, he was ever prominent in attempting to secure better conditions and more leisure for the working classes; while in his own spare time he produced two standard anthropological works, "Prehistoric Times" and "The Origin of Civilization," as well as such books as "The Origin and Metamorphoses of Insects," "British Wild Flowers," "The Senses, Instincts and Intelligence of Animals," "The Beauties of Nature," "Flowers, Fruits and Leaves," and "The Pleasures of Life" and "The Use of Life."

Seldom has a man made better use of his life than Lord Avebury. The son of a banker baronet, he was born in 1834, left Eton at the age of 14 for his father's business, and succeeded to his father's baronetcy in 1865. As M.P. for Maidstone, and later for the University of London, he sponsored bills in Parliament which included, in addition to the two mentioned, measures for the preservation of open spaces and ancient monuments, for the provision of public libraries, and for the protection of the public against absconding debtors, and earned a name also as an authority on coinage and on education, and an advocate of proportional representation. He was made a baron in 1900, and died on May 28, 1913, at Kingsgate Castle, near Margate, one of the most picturesque buildings in England, which he had bought shortly before.

Avebury's scientific and natural history works were in every sense popular; they are informed by the detailed knowledge that comes with long and loving study, as well as by a style full of charm and interest and a philosophical outlook at once sincere and humane. It is significant that all the great naturalists have been in essence kindly and generous men, as if a love of Nature inspired in them a love of humanity also; this is especially true of Lord Avebury (as his portrait shows), and nothing could have delighted him more than to know that the Easter, Whitsun and August "Mondays" and the leisure at other times which he was responsible for securing for the city workers were being spent by them in study of the marvels and beauties of Nature which he did so much to reveal.

CHARACTERISTIC SPECIES OF BRITAIN'S EDIBLE AND POISONOUS FUNGI

There are many hundreds of species of fungi found growing in Britain—some poisonous, but the great majority harmless, although even the supposedly-edible should be eaten only after the fullest examination and certainty of identification. Above, some of the most commonly encountered species in each group are represented in their actual colouring and about half life-size. *The* POISONOUS *kinds are enclosed between the* RED LINES. These illustrations are reproduced by permission of the Controller of His Majesty's Stationery Office, from Bulletin No. 23, "Edible and Poisonous Fungi," of the Ministry of Agriculture and Fisheries

To face page 293

FUNGI THAT ONE MAY, OR MUST NOT, EAT

THIS is the second chapter in this work devoted to the oft-neglected subject of fungi, the first (in page 105) being in the nature of an introduction. To the rambler confronted by a hitherto unencountered fungus the all-important question is: "May it be eaten?" and this aspect of the matter is fully dealt with in the pages that follow and also in the facing colour plate. Some fungi are poisonous; others—the majority—are harmless

THE class of cryptogams, or flowerless plants, known to the botanist as fungi is so enormous that it is well-nigh impossible to give anything like a comprehensive account of all the species which occur in Britain. In form fungi are multitudinous, varying from the common mushroom and the toadstool, through the puff-balls, to the minute leaf mould, rusts, smuts, mildews and the bacteria. The rambler in the woods and fields, however, is likely to encounter a certain number of species which, owing to their relatively large size and distinctive coloration, may be recognized by those sufficiently versed in the little-known lore of the fungus; but whereas some may be content merely to examine the fungi which they discover, many wil want to know which of the fungi are edible and which contain indigestible matter or, still more, dangerous poisons.

The number of poisonous fungi to be found by the rambler in Britain is by no means so large as is popularly believed. Dangerously poisonous fungi are, in fact, comparatively few, for there are numerous species usually designated as poisonous by country folk which actually cause no more discomfort when eaten than does a sour apple or an unripe plum.

Identifying the "Horn of Plenty"

ALTHOUGH the common mushroom (*Psalliota campestris*) (illustrated, in common with many others of the species mentioned in this chapter, in the adjoining colour plate) and the horse mushroom (*P. arvensis*) are the species most commonly eaten in this country, actually they are not so easy to recognize as many other species which are equally digestible and just as palatable. The horn of plenty (*Craterellus cornucopioides*), for example, could hardly be mistaken for any other fungus, being funnel-shaped in formation and of a dull lead colour on the outside, while the inner surface of the horn is dark brown to blackish. This species grows in tufts on the ground in the woods during the autumn months, and since no other fungus of the same shape or with the same colouring occurs in Britain at that time of the year, it is not difficult to identify. Here both formation and colouring are on the side of the fungus-hunter, while with the common mushroom the colouring of the upper surface of the pileus, which should be whitish-grey, is often highly deceptive, and the shape is very similar to that of numerous species that are known to be fatally poisonous. Therefore, in trying out the flavours of species of fungus other than the Psalliotae, it is as well to start on the horn of plenty.

To such a degree is the common mushroom accepted as the only edible species that much confusion has arisen as to the meaning of the term "mushroom," which is usually explained as connoting any edible fungus not too unlike the "common" species in formation. A considerably wider definition was suggested in Chapter 2 in this series (page 105), where a mushroom was described as "any edible fungus." In spite, however, of the various information and illustrations given here with a view to enabling the rambler to ascertain

LETHAL FLY AGARIC

This picture of the highly poisonous fly agaric shows the fine white gills terminating at the stem and the ring left by the expanding pileus during growth. The underside of the pileus of a fungus is often just as valuable in identification as the more brightly coloured upper surface.

L. Bastin

S. V. Waters

STRONGLY CONTRASTED

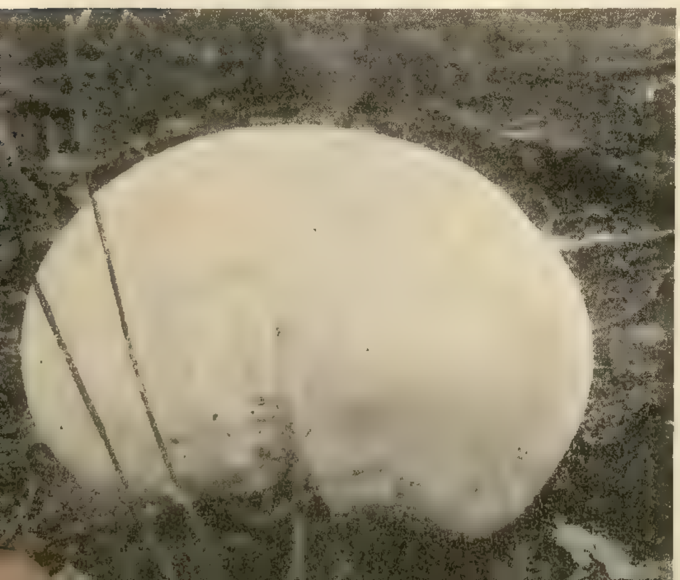
The candle-snuff or stag's horn fungus, illustrated in the left-hand photograph, although not actually poisonous, is so tough and woody that it is never eaten. It is to be found growing on rotten wood all the year round, and reaches a height of about two inches. The stem is deep black, while the tips are snow-white. Very different in shape is the grisette fungus (*Amanitopsis vaginata*), seen on the right. This is an edible, white-gilled fungus, but since many of the white-gilled species are poisonous it is unsafe to rely on this feature alone in its identification.

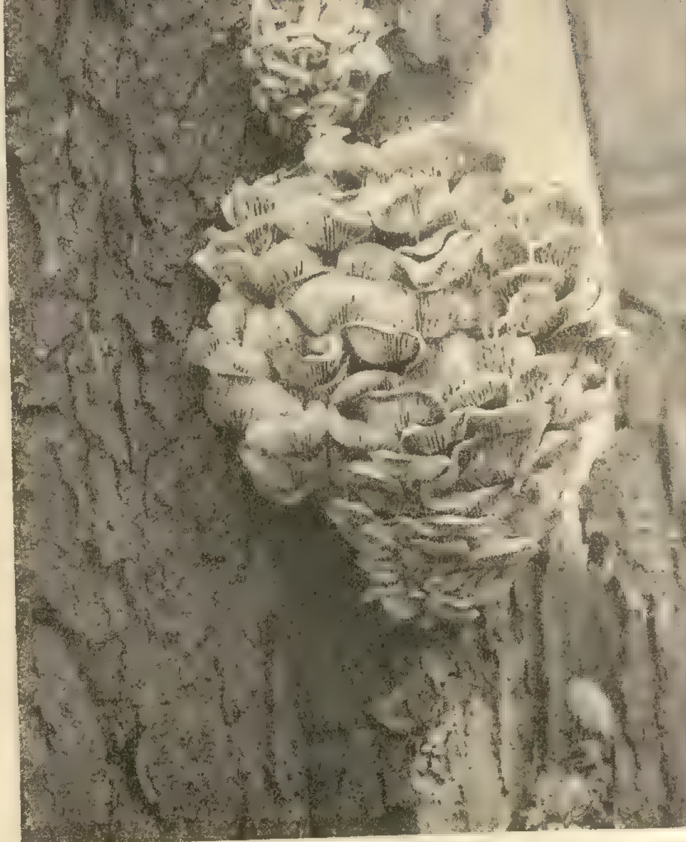
the edibility or otherwise of a fungus, it cannot be too strongly emphasized that *the only way to be on the safe side is to learn to recognize all the species, and never to eat a fungus without being certain of its identity.* When the country rambler is able to distinguish by name all the fungi which he sees on his rambles, he may consider himself in a position to discriminate between the inedible and the edible species. There are a great number of superstitions in connexion with fungi, many of which are classical in origin, as, for example, that poisonous fungi when cooked will blacken a silver spoon left in the water during the process, whereas edible species will not. None of these traditional means of distinction, however, can be relied upon, and even the skilled botanist is at a loss to provide a "rule of thumb" method. Another aspect of the problem—that of personal idiosyncrasy—cannot be ignored; and, even for the soundest digestions, it is essential that, whatever the species of fungus, it should be perfectly fresh when eaten and completely free from the attack of both insects and bacteria.

COMMON FUNGI OF QUAINT SHAPE

On the left, below, we see a fine specimen of *Lycoperdon giganteum*, the giant puff-ball, which grows to a large size—sometimes as much as two feet in diameter; its form is oval and depressed or pumpkin-shaped. The surface is white and smooth, like kid leather. This fungus is frequently eaten by country-dwellers. The unusual-looking fungus on the right is not poisonous, but is so tough that it does not make good food. The outer skin breaks open at the top, the segments folding back to give the shape from which its name—earth star—is derived.

S. V. Waters





S. V. Waters

PARASITIC FORMS

The boletus fungus is included among the edible species, but that shown above on the left is no longer good to eat, for it has been attacked by another fungus in the form of a parasitical mould which has spread over the pileus in the form of a circle. Such an attack may produce numerous toxins. The oyster mushroom (*Pleurotus ostreatus*) is an edible species which may be found growing on the trunks of trees. Its shape, colouring and manner of clustered growth give it an appearance of an oyster bed—hence its name.

Although it is often stated by country folk that any brightly coloured fungus is sure to be poisonous, this is by no means always the case; the edible chantarelle (*Cantharellus cibarius*), for instance, has a brilliant yellow tint. Certainly the poisonous purple agaric (*Cortinarius purpurescens*) is one of the brightest-coloured of our British fungi, but there are many equally poisonous fungi which are quite demurely clad. The deadly poisonous crested agaric (*Lepiota cristata*) looks at first glance much like the edible fairy ring mushroom (*Marasmius oreades*), though on closer examination it will be seen that while the agaric has a distinct ring on the stem from which the pileus broke away during the process of growth, the mushroom is without this ring. The coloration is also some indication, for the agaric is white with yellow spots, while the mushroom is of a brownish-yellow tint all over, and if the agaric fungus is picked or broken in any way, it will give off a distinct smell of radishes. Not all the agarics, however, are poisonous, for the sheathed agaric (*Amanitopsis fulva*), the scaly agaric

UNPLEASANT TO SMELL AND TASTE

On the left we see a stinkhorn fungus. One of the strangest of our woodland fungi, this species gives out such an objectionable odour that even the most ignorant are not likely to consider it as food. The wrinkled cap is covered with a greenish, foul-smelling slime, in which the spores are embedded. The fungus illustrated in the right-hand photograph, the brittle russule, though it is not so obviously objectionable as the stinkhorn, is by no means good to eat. The gills are very thick and brittle, and it has no ring on the stem or volva at the base.

S. V. Waters

V. L. Breeze

LAWYERS' WIGS

The shaggy cap (*Coprinus comatus*) is familiar to most ramblers. It is an edible fungus, safe and unmistakable; it may reach a height of nine inches. In time the cylindrical cap is broken up into shaggy scales, as seen in the colour plate, facing page 293.

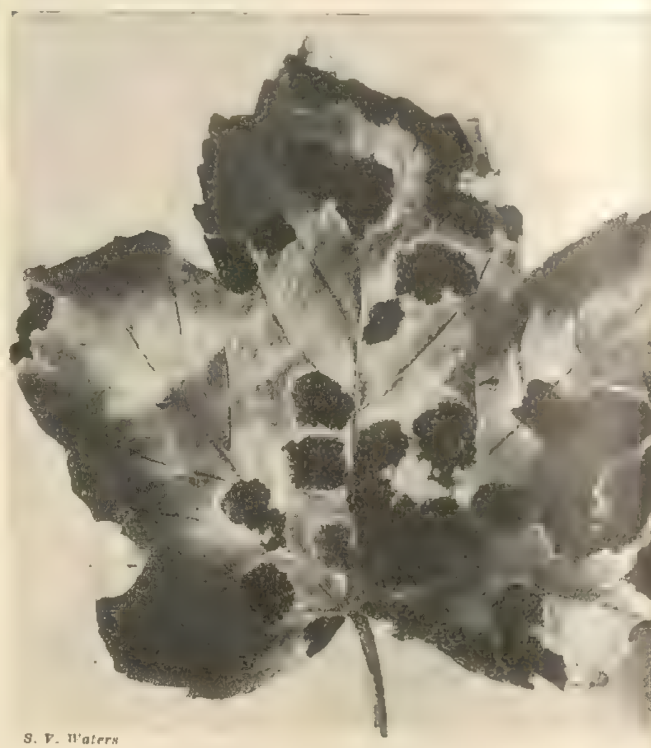
(*Lepiota rhacodes*) and the amethyst agaric (*Tricholoma nudum*) can be eaten, and each has its own particular flavour. On the other hand, the fly agaric (*Amanita muscaria*), which is bright scarlet, the verdigris agaric (*Stropharia aeruginosa*) and the warted agaric (*Amanita pantherina*) are deadly poison.

LIKE the horn of plenty and the chantarelle, the common morel (*Morchella esculenta*) is an easily recognizable edible species, for there is no poisonous species with which it may be confused. Found in spring, the Morchellae are among the commonest fungi, occurring in clearings, especially on chalky or clayey soil. The formation of this fungus is entirely different from that of the ordinary mushroom or " toadstool " type, for the cap grows down well over the stem and is deeply ridged, giving a honeycomb effect. It is of a dark brownish-black coloration, while the stem is whitish, grooved towards the base, mealy and very brittle. Both the cap and the stem are hollow.

The giant puff-ball (*Lycoperdon giganteum*) is an edible species which, when mature, could never be mistaken for any other, owing to its great size. Specimens have been recorded four times as large as a two-pound loaf. If picked while it is still fleshy and before it has developed its spores, it can be cut into slices and fried.

THE edible boletus (*Boletus edulis*) and blewits (*Tricholoma personatum*) are two species which, although not much eaten in this country, are used a great deal in continental kitchens for flavouring. The shaggy cap or lawyer's wig (*Coprinus comatus*) and the warty cap (*Amanita rubescens*) are another pair of edible fungi. The warty cap may be distinguished from other similar fungi which are poisonous by the fact that the flesh when broken changes its colour from white to red. For this reason it is sometimes known as " the blusher." Another species which may be distinguished by breaking the flesh is the poisonous yellow-staining mushroom (*Psalliota xanthoderma*), which will produce a yellow stain on any object with which it may come in contact.

The death cap (*Amanita phalloides*) is the most poisonous of all our fungi and well deserves its name, for it has been estimated that about 90 per cent of the deaths caused by fungus-poisoning are due to this species. Even very small quantities will give rise to extremely grave symptoms and often death. It may be recognized from its picture in the colour plate facing page 293.



S. V. Waters

LEAF-KILLING MYCELE

As an illustration of the great extent of the cryptogamous class of plants, this picture of a sycamore leaf attacked by " blotch " is included here. Tiny spores infest the young leaves, and yellow spots appear in summer, gradually turning to black with the approach of autumn. The minute mycele eventually kill the leaf and in time the whole tree may be destroyed.

Once again, then, let it be emphasized that no fungus should be eaten, cooked or raw, unless there is absolute certainty that it is quite harmless. If there is the slightest doubt, the merest suspicion that it belongs to the inedible and dangerous group, then it should be thrown away without a moment's hesitation.

A HANDFUL OF NETTLES—STINGING AND 'DEAD'

MANY people, probably, will be surprised to find nettles described in this series of chapters concerned with our wild flowers, but there is every reason for their inclusion. Popularly divided into two main groups—those that can sting and those that are "dead" or harmless —nettles are of many varieties, the principal being those mentioned in the following pages

IT is probable that no plant is so well known, by repute at least, as the stinging nettle, and almost everyone, sooner or later, makes a more or less painful personal contact with it. To most people it is, accordingly, just a nettle, an unpleasant plant that should be avoided whenever possible, and one which could well be done without. To the naturalist, on the other hand, the nettle is a plant full of interest, and in many ways one that repays closer study.

Few people ever notice the flowers of the nettle, and probably fewer still realize that they are flowers at all. If one were to ask a countryman—who would obviously know the nettle well by sight, and perhaps had spent much time cutting back these vigorous plants at the base of the hedgerows—what sort of a flower it had, he would almost certainly be unable to give a satisfactory answer. As a matter of fact, the flowers of the stinging nettle are of two types, each of which is equally insignificant to the casual passer-by and equally interesting to the naturalist. The male flowers are borne in what is known as a *panicle*, that is, an inflorescence in which the flowers are on side branches from a main stalk. They are very tiny, are green in colour, and consist simply of four sepals and four stamens; the diameter of a single flower is about an eighth of an inch. The female flowers are in little, dense clusters, and consist of two sepals and a single pistil. In view of the nature of their flowers, the pellitory, described in Chapter 35 of this series (page 1090), and the hop (page 803) are included by botanists in the nettle family; until recently the elm tree also was in this family.

The leaves of the stinging nettle may be botanically described as ovate-cordate; their margins are serrated and they bear large numbers of the hairs which are responsible for the stings. These hairs, which are also present all over the stems of the plant, are much longer than the other hairs with which the leaves are clothed. Each stinging hair is armed at its tip with a sharp little point of hardened tissue, which can easily pierce the skin, and thereupon breaks off. The hair is hollow, and has at its base a gland which contains a drop of formic acid, the same acid that is found in the sting of ants. This acid rushes up into the hole in one's finger made by the point, and the soreness of the sting is the result of the action of the acid. If we grasp the nettle very firmly, the hairs are broken off low down and the tips are unable to pierce the skin; we then escape with impunity. Some members of the nettle tribe found abroad have far worse stings than ours and are capable of inflicting a really severe wound if handled incautiously.

EXTREMELY tough and strong, the stem of the stinging nettle is largely composed of fibres which were formerly often used as a substitute for hemp. In strong contrast to the plant's unpleasant qualities is the fact that the young shoots and the tops of such shoots as have a fair crop of tender leaves may be boiled and used as a vegetable, being very palatable if care is taken to include only the youngest and greenest shoots.

Besides the common stinging nettle, which is also known as the great nettle, we have in the British Isles two other species, the small nettle and the Roman nettle. The small nettle is a little, low-growing plant with

NETTLES IN FLOWER

Few people ever notice the flowers of the common stinging nettle, for they are green and insignificant, and when we encounter the plant we are more concerned with its stings (illustrated in "Nature under the Microscope") than with its blossoms. Besides the masses of flowers, this picture well shows the way in which the nettles stand as a venomous army round the base of the hedgerow.

R. A. Malby

Dennis and Malby

WITH STINGS AND WITHOUT

Of the three nettles seen in the photographs above, only the one in the centre possesses leaves armed with stinging hairs. This is the Roman nettle, and its sting is of even greater virulence than that of the common nettle. The yellow dead nettle (left), also known as the archangel, and the red dead nettle (right) resemble only in their leaves the Roman species; their flowers are quite typical of the order *Labiatae*, having the characteristic upper and lower lips. In the Roman, on the other hand, the male and female flowers are separate, the latter being collected into large ball-like masses.

elliptical leaves and a more shrubby growth than the common nettle. The leaves are greener and darker, and the plant, though very common on waste ground, is likely to escape notice on account of its entirely insignificant appearance. It can, however, inflict as bad a sting as the common nettle. The flowers are borne in closer masses and there are from three to five sepals and four or five stamens.

A larger plant than either of the others, the Roman nettle is rather local in its distribution. The flowers are of the same type as those of the other varieties, but they are considerably larger, and the female flowers are borne in rounded clusters about half an inch across.

Features of the "Dead" Nettles

So characteristic is the shape of the leaves of the common nettle that they have given their name to many other plants, such as the nettle-leaved bellflower and the various species of so-called "dead" nettles. These last, which are, in reality, not related to the true stinging nettle, are very common, and, before they flower, may often be mistaken for that plant, although with a little practice one can tell the various species at a glance at any time of the year.

One of the commonest plants of the wayside and hedgerow, the white dead nettle is the first member to be described of the very large order *Labiatae.* The plants of this order are characterized by the curious lips into which the perianth is developed, and which give the order its name, *labium* being the Latin for lip. The perianth is divided into two lips, an upper and lower, the upper often forming a sort of hood and the lower being usually cleft into three sections. The calyx may also be similarly lobed, but is more often cut into five pointed segments. The ovary is divided into four parts, each of which gives rise to a little nut-like fruit, which contains the seed. There are four stamens, of which two are commonly a great deal longer than the other two, or may at times be absent. The single style bears a two-cleft stigma.

Further features that are common to the members of the Labiatae are the leaves, which are opposite, and the fact that the stems are almost invariably four-sided. To this order belong many of the herbs, such as mint, sage and thyme, and a very large proportion of its members are used by the herbalist as remedies for various disorders.

The white dead nettle itself is a strong and unmistakable plant. During the early part of the year, before the flowers are out, it certainly may be confused with the stinging nettle, for the leaves of the two plants are very similar. The leaves of the dead nettle, however, are covered with softer hairs, and are quite harmless, whence the name, and also the older name, dumb nettle. The square and more brittle stem, and the fact that there is something less hard in the whole appearance of the plant, should serve to distinguish it once we have become thoroughly acquainted with both species.

Conspicuous in the Spring Hedgerows

Pure white in colour, and projecting some way from the green, five-cleft calyx, the flowers make the white dead nettle a very conspicuous plant in the spring. They are borne in whorls of from six to ten at a time, the corolla forming a tube over half an inch in length, and then dividing into two very well-marked lips, of which the upper one sticks straight upright as a hood, while the lower spreads out in much the same way as that of the early purple orchis described in Chapter 6 of this series (page 174). The four black stamens make a noticeable feature in the middle of this flower.

E. A. Malby

STRIPED LEAVES

A near relative of the red dead nettle, the plant seen in this photograph is known from its leaves as the spotted dead nettle, and is often found in a wild state, although its variegated foliage wins for it a place in many a garden. Its flowers are reddish-purple in colour, and it is in most respects very similar to its common red cousin.

As may be expected from the devices in other flowers already described, the development of this curious form of flower is merely an adaptation of the plant to secure adequate cross-fertilization by insects. The concave hood formed by the upper lip contains the two long stamens, and when a bee, having alighted on the lower lip, reaches down to find the nectar at the bottom of the corolla tube, its back comes into contact with the anthers, which then shed their pollen. The style and stigma are held between the two long stamens in the upper lip, and some pollen from a flower that the bee has already visited is thus transferred to the stigma. In this way one bee may act as agent in the cross-fertilization of many flowers of the dead nettle.

In the more woody lanes, and growing on the leafy banks of the oak woods, we may notice a plant that has rather longer, finer leaves than those of the white dead nettle, but which is otherwise very similar. If we find it in flower, the similarity is even more marked, for the flowers are almost exactly like those of the white dead nettle, except that they are of a fine, rich yellow colour. Usually known as the archangel, this plant is also sometimes called the yellow dead nettle, and is really a quite close relative of the white form, although a few botanists place it in a different genus.

A further species of dead nettle is one of the commonest of all the plants that grow up when any piece of land becomes waste and produces its own flora. This is the red, or, as it is sometimes called, the purple dead nettle, whose flowers and leaves are of very much the same type, though rather smaller. The leaves, as a matter of fact, are somewhat hairy and are of a slightly greyish green, often tinged with reddish-purple. They tend to be crowded together at the tops of the stems, which are frequently weak and rather sprawling, as compared with the very straight, upright growth of the white and yellow dead nettles. The leaves are more crenate than serrate, and the purplish-pink flowers are about a quarter of an inch in diameter. The spotted dead nettle, seen in the photograph above, differs only in detail from the red species. For the beauty of its foliage it is a popular garden plant.

DEAD ONLY IN NAME

Known as a dead nettle on account of its inability to sting, the white dead nettle, seen below, is one of the commonest and most ornamental of the spring hedgerow flowers. Notice the curiously attractive shape of the flowers, their upper lip forming a canopy, while the lower lip is a landing stage for the fertilizing bees.

[illegible]ley

The cut-leaved dead nettle is similar to the last, but the leaves are more heart-shaped, and are more deeply cut round the margins. Whereas in the red dead nettle the corolla tube is distinctly longer than the calyx, in this plant it is shorter, so that the corolla only just projects beyond the sepals. Henbit dead nettle is another somewhat similar species, whose flowers are darker purple than those of either of the two preceding species. The calyx is very hairy and is as long as the corolla tube, and the leaves, though rounded and blunt, are very deeply crenate; the upper leaves, moreover, are sessile. This species is frequently found in fields and waste places.

GRATEFUL GREENERY OF THE SUMMER LIMES

In the height of summer, when the sun blazes down on a dry and dusty earth, the shady lime is always sure of a welcome. But the tree has other features for which we may be grateful—its delicate flowers, for instance, and the rather unusual manner of its growth. Then there are the bees that get intoxicated on its secreted nectar, and the larvae that feed amongst its boughs. With these varied aspects the following chapter is concerned

Many trees and flowers may compete for the title of "herald of spring," but as a harbinger of summer there is no tree to rival the lime. During the early part of the year we scarcely notice it, for it has no brilliant blossoms to attract our attention, nor do its leaves make any great show as they unfold. It is in the first hot days of late spring and early summer that we become aware of the lime, for it is one of the most delicate of our trees in its foliage, and one of the finest and most impressive regarded as a whole.

The leaves of the lime vary greatly in size, and to this fact is due the formation of two sub-species, known as the broad-leaved lime and the small-leaved lime. The

B. Hanley

FOOD FOR THE BEES

Amongst all our trees, none has more attractive flowers from the insects' point of view than the lime, and in summer such bunches as those shown above are simply swarming with drowsy, drunken bees. The curious bracts from which the flower-stalks spring are even more conspicuous in autumn, for they persist long after the leaves have fallen to the ground.

broad-leaved variety is a true native, while the small-leaved is doubtfully native; the common variety, though the most widely distributed in town and country, is an introduced species.

The following description applies equally well to all three species of lime, since the differences between them are slight. The leaves, which are borne on alternate sides, are roughly cordate in shape and have serrated edges, and are often unequal-sided in the same way as those of the elm, described in page 145. They are exceedingly thin and delicate, a fact which gives a very distinctive character to the shade of the lime tree, for the leaves seem to keep out the heat without causing any diminution in the amount of light; beneath limes a greenish glow fills the atmosphere, and emphasizes the delicious coolness of their shade. In colour the leaves are a bright golden-green, which, when they are very young, rivals in intensity the green of the beech leaves.

The flowers of the lime appear in June, and show another feature in which this tree differs from the rest of our larger trees. They are complete with five sepals and five petals, the latter being yellowish-white in colour, and there are a large number of stamens. The flowers are borne in a *cyme*, a type of inflorescence in which the flowers, which spring from an irregularly-branched stalk, appear all on the same level. The common stem from which the small flower-stalks spring, is, in the lime, the midrib of a long, leaf-like yellowish bract, a point even more noticeable later in the year, when the ripe fruits fall to the ground. The fruits are rounded, yellow in colour, and covered with down, but they do not often get a chance to ripen in the British Isles, as they require a somewhat hotter climate. If they do ripen, they will be found to contain one or two small seeds.

RUGGED AND LICHENED

One of the handsomest of all our trees, the lime is divided into several sub-species, but the boles of all display the same typical characters. Here we see a representative bole—straight, and covered with rough bark that flakes off and is never very deeply cleft. Often, as here, it bears a generous crop of greyish lichen

H. [illegible]

Most of the common trees found in the British Isles are content to rely on the wind for the distribution of their pollen and the consequent fertilization of the flowers. This is largely because they flower at such an early season that few insects are about. The lime, however, has an ample store of nectar, and is therefore able to rely on insects to do the work that otherwise must be left to the wind. No one who has stood underneath a big lime tree when it is in flower can long remain in doubt whether or not the flowers attract insects, for not only will a steady hum be heard, as the bees, hungry for nectar, perform their unconscious task, but very often a miniature shower of what look like dead or dying bees will fall from the trees. Many of these will have been pecked to pieces by small birds, usually great tits, which flock to the limes when they are in flower to feed on the bees; but the naturalist must beware of picking up any of the bees, for they may prove to be not dead, but merely drunk, and not too drunk to sting!


R. St. Barbe Baker

REGIMENT OF LIMES

Said to have been planted by Queen Anne in memory of her numerous children, these magnificent limes are one of the chief ornaments of Ashridge Park in Hertfordshire. The great branches bend and curve downwards so that there is a cool and generous shade all along the walk lined by these splendid trees.

Lime Has Its Uses

FEW trees that attain such a size as does the lime are so useless from the point of view of the timber merchant. The wood is soft and not durable, and, as timber in the normal sense, is quite without value. On account of its lightness and its fine grain, however, it finds a use in a few trades, being one of the favourite woods of the musical instrument maker, and being also employed to a considerable extent by wood-carvers. It was in lime wood that the great wood-carver, Grinling Gibbons, carried out many of his finest masterpieces. The wooden bucklers of olden times were made from the wood of the lime, and the bast tissue was used for the manufacture of the bast mats formerly imported in large quantities from Russia.

The lime is one of the longest-lived of our trees, often reaching an age of four hundred years, and for this reason it is also, when mature, one of the largest and most impressive of trees. In height it may reach a hundred feet, and the fine, upright growth makes it a very suitable tree for planting in avenues. Numbers of splendid lime avenues are to be found in all parts of the country, those at Hampton Court and Bushey Park being among the finest near London, while there are many magnificent specimens of individual trees in the parks.

Not so rugged as that of most of our forest trees, the bole of the lime is none the less strongly built, the bark being cut into shallower grooves and cracks than one might expect in so large a tree. The manner of growth of the tree is rather curious, since many of the branches grow outwards from the trunk, turn so that they begin to grow downwards, and then suddenly change direction through almost a right angle, giving a curiously elbowed effect. There is usually one tall main trunk, with a large number of fair-sized lateral branches, but only too often the tree is subjected to ruthless pollarding in the interests of suburban neatness, and to the townsman the lime may be little more than a thick trunk, 15 feet high, which produces every summer a number of strong shoots with large leaves borne on them, which may be cut back again in the winter. The way in which the trees will endure such treatment year after year testifies to their strength and ability to resist adverse conditions, for many species would die in a year or two if thus maltreated.

Growing in the open, in the orderly ranks of some stately avenue, or in the heart of a wood on rich, light, loamy

POLLARDED AVENUE

The lower shoots of these three centuries old Sussex limes have been severely pollarded, so that there are no large branches on the boles. Notwithstanding this treatment, the many small shoots are an indication that the trees' vitality is unimpaired.

soil, the lime is a very attractive tree, as beautiful as any we have already described; it is possessed in particular of an especial and peculiar loveliness due to its foliage and the delicate manner of its growth. An interesting point about the lime is the way in which the twists and elbows of its smaller branches seem to have been specially arranged to give ideal handles for home-made walking sticks. But it is never worth while taking the trouble to cut one of these sticks, since the wood is so soft and poor that it will break even under the slight strains to which it may be subjected on an ordinary day's walk.

Of the insect fauna attracted by the lime, the lime hawk moth is the chief moth that dwells among the boughs of the tree, but there are plenty of other moths whose larvae may be found feeding on the lower shoots, while among the inaccessible parts of the upper branches there are numerous caterpillars at work. Lime trees are among those that suffer in certain seasons from the attacks of swarms of caterpillars, which almost completely defoliate them, but they seem well able to withstand such onslaughts. It is regrettable that the foliage is rather short-lived, for the lime in leaf is not only very lovely, but provides welcome shade in our cities.

The following summary will serve to bring out the differences between the three varieties of the lime more clearly.

Small-leaved lime. A smaller tree than either of the other two, with leaves about 2 inches across. Between the axils of the veins there are hairy patches on the undersides of the leaves, and the leaf is often slightly lobed.

Common or intermediate lime. This tree is larger and coarser than the last-named. The leaves are about 3 inches across, the twigs smooth, and the fruits woody in texture and without raised ribs.

Broad-leaved lime. In this tree the leaves are often more than 4 inches across. The twigs are hairy, and the fruits, which are woody, are strongly ribbed.

LIME LUXURIANCE

Great is the contrast between the superb lime shown in the opposite page, flaunting the glorious, semi-transparent foliage of its summer dress, and the pollarded specimens pictured above in their wintry nakedness.

WHEN THE SPIDER GOES A-WOOING

AMONG the many extraordinary tales of animal behaviour included in this work, those included in this chapter on spider courtship and mating are surely hard to rival. Each species seems to display som peculiar nicety of wooing technique, and in several the path of the spider suitor seems beset with dangers and menacing pitfalls. To be unlucky in love is for some spiders a matter of life and death

THE subject of animal courtship is one of never-failing interest, and despite the vast amount of investigation to which it has given rise, it continues to provide us with many an unsolved problem. Thus the old controversy concerning the part played by the "secondary sexual characters"—the peacock's gaudy plumage, for instance—in the processes of courtship and mating is still unresolved. The problems of origin and meaning may be left, however, to the biologist; for the naturalist there is a wealth of instruction, entertainment even, to be derived from observation of the amatory preliminaries of the animal creation. And of these courtship incidents, among the most extraordinary are those associated with spiders.

The habits of the large garden spider (*Epeira diademata*), which is one of the species that build geometrical webs, may serve to demonstrate the general courtship behaviour of spiders.

The courtship of these spiders has been observed by a number of naturalists, and all who have done so have been fascinated first by the extraordinary behaviour of the male when soliciting the attentions of the female. The whole process is carried out by a curious system of telegraphic signals sent by the male spider to the female along the silken threads of the web. Every female spider, after building the web in which she intends to catch her prey for the purposes of food, lays down a special telegraphic cable of silken threads, which is connected to the centre of the web and runs off to her lair among the surrounding branches of the tree or bush.

TRYSTING PLACE

To this maze of silken tunnels, woven of threads among the spikes of a gorse-bush, the male labyrinth spider comes at the beginning of his courtship, and endeavours to attract the attention of the female whose home it is by twitching at the gossamer lines on the confines of the nest. (Approx. life-size).

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Perils of the Spider's Wooing

DURING the mating season the male spider, who is almost ridiculously small in comparison with the female, finds his way to the web of a female of the same species, and spends a considerable time in crawling about in search of the telegraphic cable. Once this is found, he clutches it with his fore-feet, and by means of a quick jerking movement sends along it a number of telegraphic signals, the meanings of which are evidently quite clear to the female resting on the web. For hours he will linger at the end of the silken thread, feeling it every now and then with his long, slender legs in an apparent endeavour to divine from the vibrations which it conveys to him from the female the kind of welcome with which he will be received. This hesitation on the part of the male spider is a sensible precaution, for he is engaged in a very perilous form of courtship. Not only will his chances of winning the female spider's affection be ruined if he makes a mistake, but there is every possibility that she will leave her web to attack and devour him before he can escape. For the female to eat the male if she is not pleased with him is a very common occurrence in the world of spiders.

Assuming that this fate has not overwhelmed the male spider, he next ventures after a time on to the edge of the web, and here he is met by the female. But it is only after a series of somewhat threatening gestures and a considerable display of coyness that she at last allows the process of mating to take place; and even when it is ended the male is still in danger, for if he does not remove himself quickly from the scene of his activities he again runs the risk of being eaten alive.

In nearly all species of spiders the males, though generally more active, are smaller than the females,

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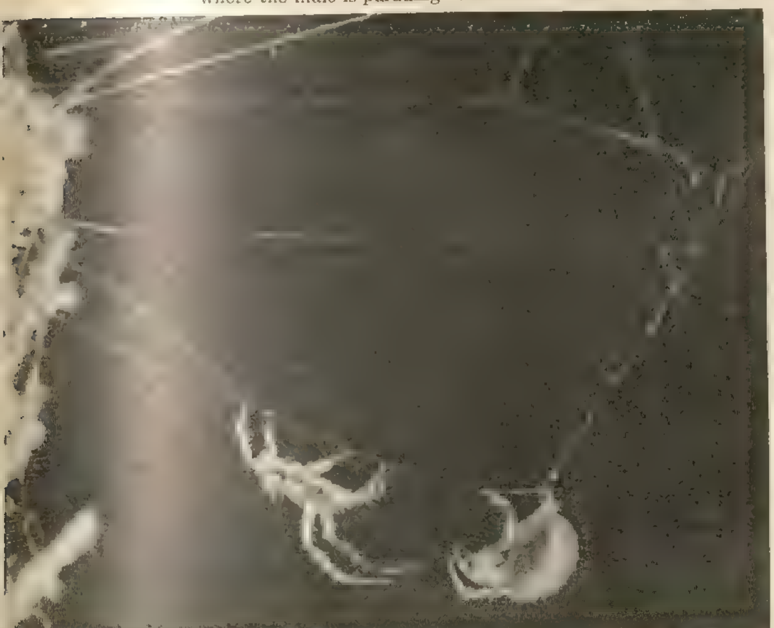
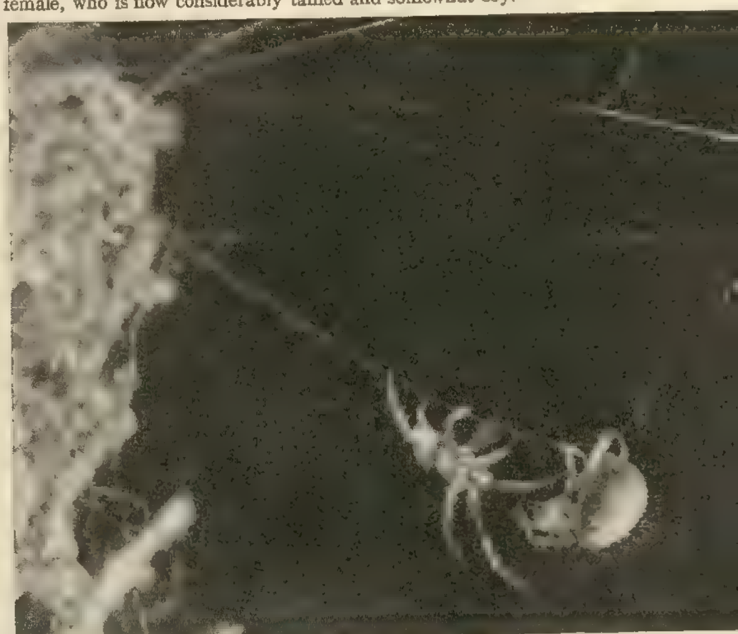
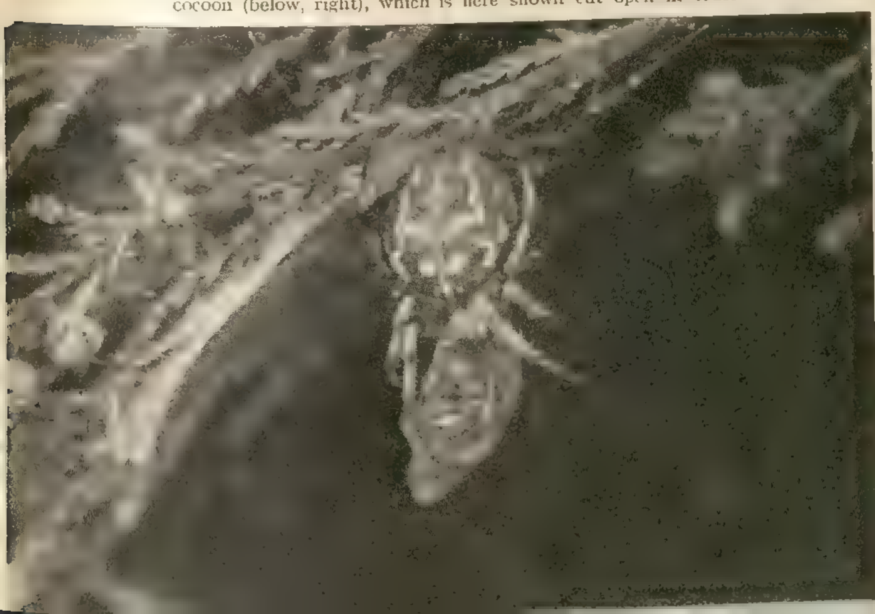
EPISODES IN THE DANGEROUS COURSE OF A SPIDER'S WOOING

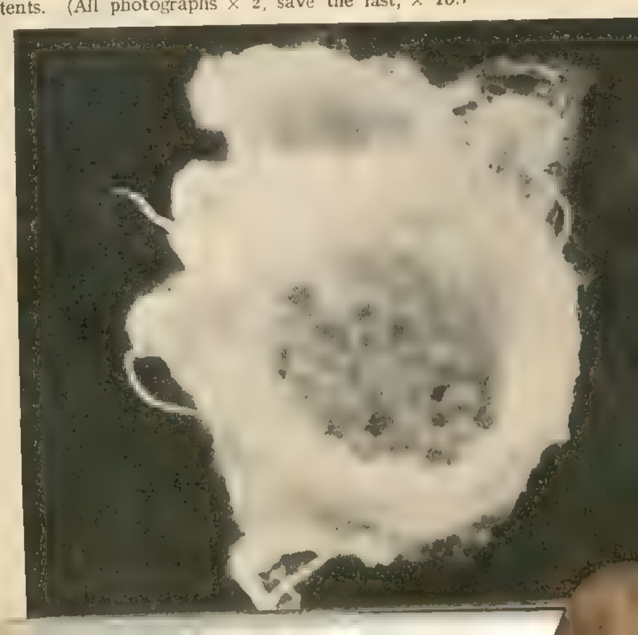
In the series of photographs in this page we watch the course of a garden spider's courtship and mating from the first twitching of the silken threads of the web to the production of the neat little nest of eggs contained within the cocoon. After "ringing the front-door bell" for quite a time (left, above) the little male at last dares to approach nearer the female (right, above), though she threatens him with death if he is too bold, and will not hesitate to eat him alive if he does not suit her fancy. Below, left, the scene changes to another part of the web, where the male is parading himself with raised front legs before the female, who is now considerably tamed and somewhat coy.

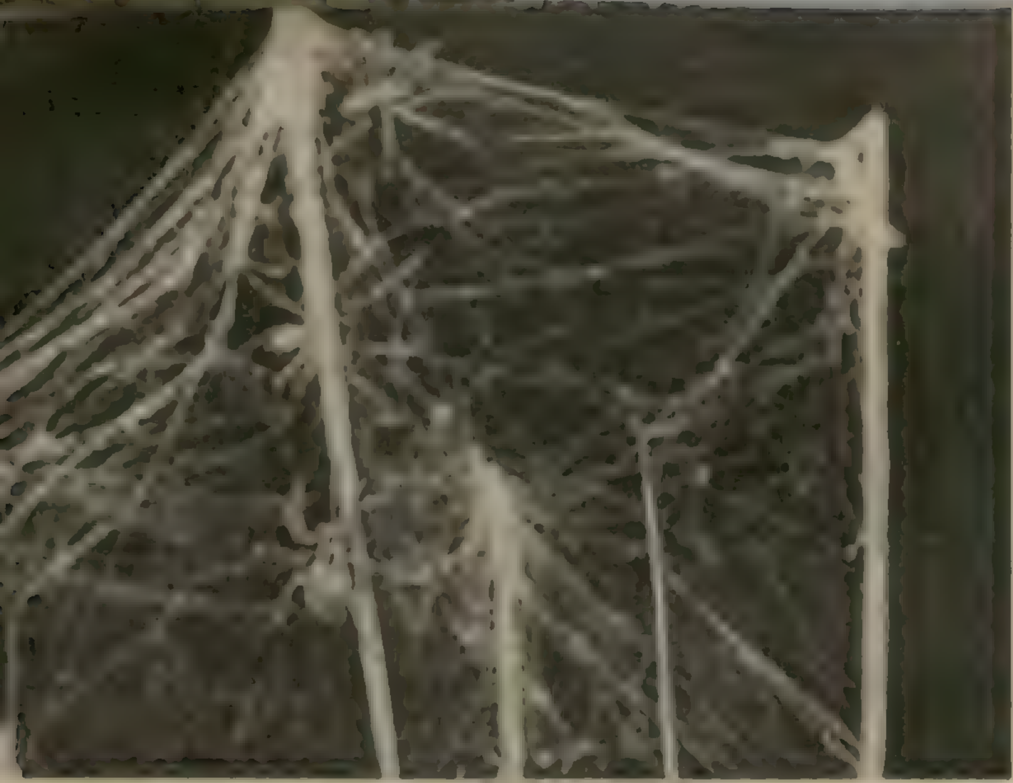




By continually raising his front legs and twitching the thread (above, right), the male persuades the lady of his choice to allow of his approach, and mating eventually takes place near the branches by the side of the web (below, left). Even when his wooing has been so far approved, he dare not linger a moment longer than he is obviously welcome, for the fact that he has been her lover does not make the female spider feel any more kindly towards him. Finally, when the time comes, the eggs are laid and enclosed within the cocoon (below, right), which is here shown cut open in order to reveal its contents. (All photographs × 2, save the last, × 10.)

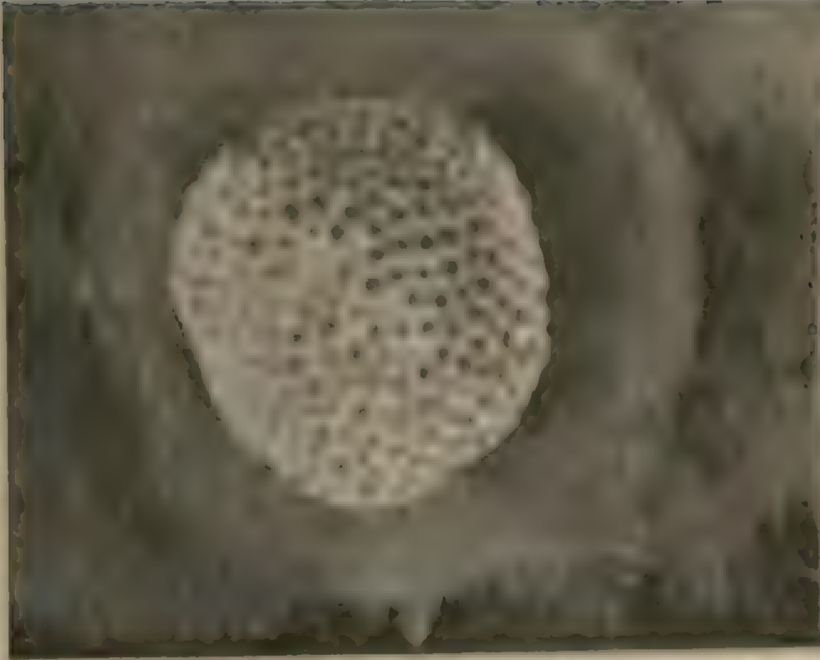






ETERNAL TRIANGLE

SPIDER CARESSES



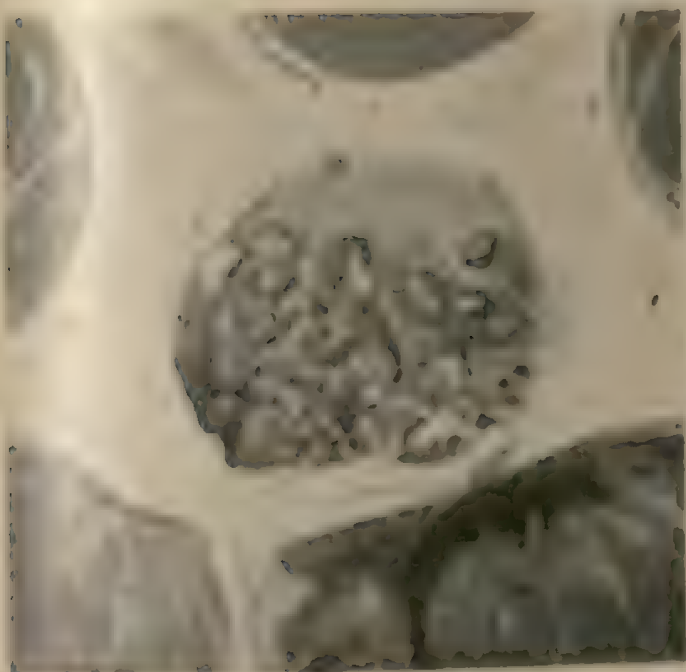


TABLE FISH OF FLATTENED FORM

THE housewife may be expected to know quite a lot about the species of sea-fish that enter into our dietary, but (as will be seen from the chapter below) a fish is not always what it is called by the fishmonger. Among the fish described here are the soles and dabs, the flounder, the turbot and the halibut

IN Chapter I of this series (page 190) we saw how the plaice, hatching as a normal fish, gradually develops into a flat-fish with its two eyes on the upper side. The plaice is not alone in this peculiarity, for there is a whole group of bony fishes, the *Pleuronectidae* (Gr. *pleuron*, rib; *nektes*, swimmer), which show a similar disarrangement of symmetry due to bottom feeding and sedentary habits. But care must be taken not to confuse these flat-fish with the other fish of flattened shape, the skates and the rays, which belong to a different sub-class of fishes and in which the flattening is achieved without loss of symmetry.

SEA-FISH ARISTOCRAT

Many fish are sold as soles, but none except the true soles possess the characteristic shape. Here we see the under-surface of the sole and the whole of its fin formation and general shape, as it swims upward through the water. Its neighbour in this photograph is a starfish.

N. Kingston

The Pleuronectidae include some of the most important fish found in British coastal waters, for the excellent food provided by many of them has ranked them among the chief fishes of our markets. For this reason more research work has been carried out on the plaice and soles, their spawning grounds and migratory habits, than on almost any other sea-fish. The majority of the Pleuronectids are edible, though some, on account of the dryness of their flesh or their small size, are negligible as a source of food supply.

Of Pleuronectids there are four main groups, which are classified according to the position of the eyes, teeth and jaws. The first group, in which the eyes are on the right side and the teeth mainly on the blind side, includes the plaice, lemon sole, witch, dab and flounder. These five fish are all closely related and are similar to one another in general appearance and in flavour.

ALTHOUGH they are all edible it is well to examine them carefully as they lie on the fishmonger's slab, since they are frequently sold under deceptive names, suggesting that they are allied to the sole. Thus the lemon sole may be bought by people who do not realize that the fish is a form of plaice, while the name "Yarmouth sole" is also frequently used as a trade term for flat-fish. Unsuspecting people are often inveigled into buying these fish by the misleading but legitimate nomenclature of the trade. Less defensible is the custom of selling these Pleuronectids as soles—true or "Dover" soles. This last trick is a serious hindrance to the trade, since people who buy fish in this way are usually very disappointed with their purchase. Unscrupulous traders may, however, be circumvented if one makes a careful scrutiny of the flat-fish and notes their differences. Those fish that are allied to the plaice have more prominent jaws than are found in the soles, and the fin does not surround the body to the same extent.

Best-known of our British flat-fish is the plaice, but the lemon sole approaches it closely in importance and

W. S. Berridge

IMPUDENT IMPOSTOR

The lemon sole is a near relation of the plaice. In spite of a superficial resemblance to the sole it has no right to its name, which is a fiction of the fishmonger. A close scrutiny will soon reveal the essential differences between the two fish.

is also a familiar object to the cook and housekeeper. The lemon sole, as its name implies, is of a yellowish-brown colour, with darker or lighter spots. It has a wide range, and lives in waters of medium depth, being seldom found inshore or beyond the fifty-fathom limit. The lemon sole is smaller than the plaice, a fair-sized fish measuring twelve or fourteen inches in length, but it is good eating, though not nearly so excellent as the sole in this respect. The witch is another of the plaice family which is often found in fish shops masquerading as a sole, though it can be detected easily by its larger eyes and projecting mouth. It is seldom found inshore, living on the sea floor, most usually beyond the fifty-fathom line. Opposed in habit to the witch is the dab, the smallest of the British flat-fish, which lives close inshore and is almost indistinguishable from the sand, so that it frequently surprises bathers by springing to life unexpectedly beneath their feet. Somewhat similar to the dab and often confused with it is the flounder, a member of the plaice family which, though commercially unimportant, is one of the most interesting to the naturalist, for it inhabits brackish water, even ascending the rivers for some distance inland. Unlike the salmon, the flounder travels upstream in search of food only, returning to the sea to spawn. The flounder may be distinguished from the dab by the whiteness of its under-surface, a characteristic which has earned it the name of the white fluke.

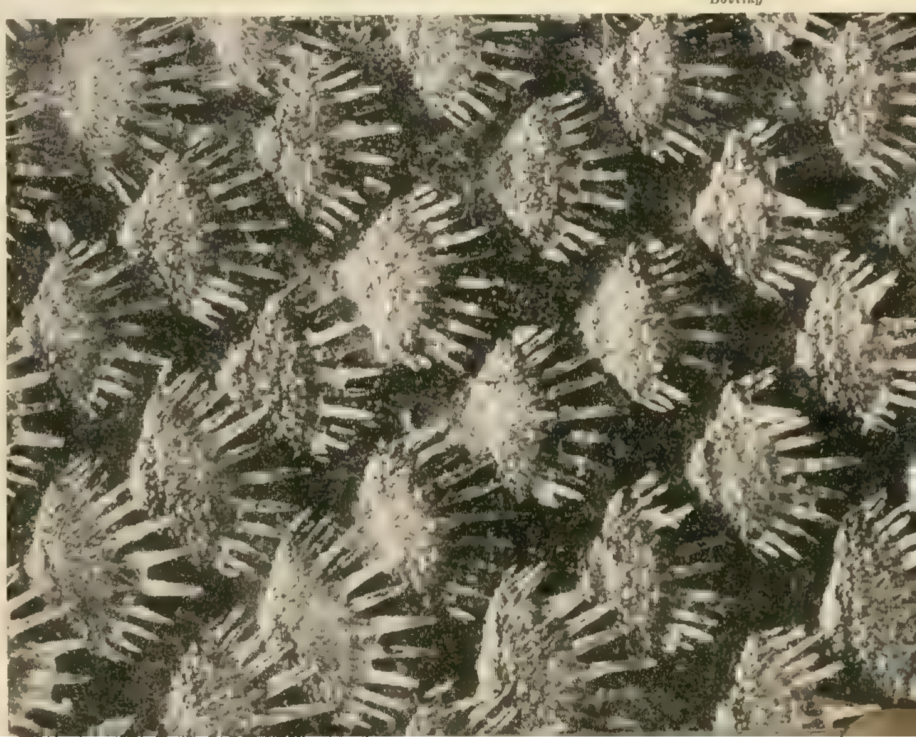
SOLES, which constitute the second of the four groups, are the aristocrats of the common British sea-fish, for they are regarded as the best eating of any sea-fish except the royal sturgeon, and are rivalled only by the turbot. For this reason there is always a demand for them, and a catch of sole is easily marketed. We have seen that many of the flat-fish are marketed as soles often with some prefix such as "lemon" or "Yarmouth," and sometimes without any qualification at all. A sole, however, may be readily distinguished from all other flat-fish by its longer shape, more flexible body and, particularly, by the shape of its head, which extends round and beyond the jaws and mouth. The colour of the common sole is a mottled brown and grey, and it has a particularly rough skin covered with small, bristly scales. A small species of sole, called the solonette, frequents the inshore waters of the British coasts, but its size renders it impracticable as a marketable fish. The thickback and sand soles occur rarely in our seas.

FORMING the third group are two large flat-fish, the halibut and the long rough dab. The halibut is the largest of the flat-fish, one specimen being recorded with a length of seven and a half feet and a weight of 320 pounds. From the fact that the halibut is more often caught on a line than by the net, it would seem as if it inhabited a sea floor with a rocky bottom where trawling is impossible. This theory is also borne out by the fact that one of the best fishing grounds for halibut s near the island of Valentia, off the rocky south-west

PRICKLES FOR PROTECTION

The sole's skin is rough to the touch, and in this photograph, magnified 18 times, the reason is made apparent. Each one of the scales is developed, it will be seen, into a plate from which grow a number of sharp spikes.

Bolting



coast of Ireland, where they afford great sport to the sea anglers and are regarded as one of the most sporting of sea-fish. The large halibut, with its olive-green back and white under-surface, is a magnificent fish, and not only does it afford good sport, but it compares not unfavourably with the turbot as an edible fish. The halibut is a deep-water fish of very wide range, and is found in all the British seas. The long rough dab is similar to the halibut in shape, but is smaller and has rougher scales. Although it is also a northern species of fish, the long rough dab has a less wide range than the halibut.

Berridge

TURBOT TRICKERY

The turbot is one of the better-known of our [illegible] fish. Like many of the Pleuronectids it adopts protect[illegible] [illegible]ring to ensure its safety. This picture shows how effective it is at camouflaging itself against a sandy bott[om].

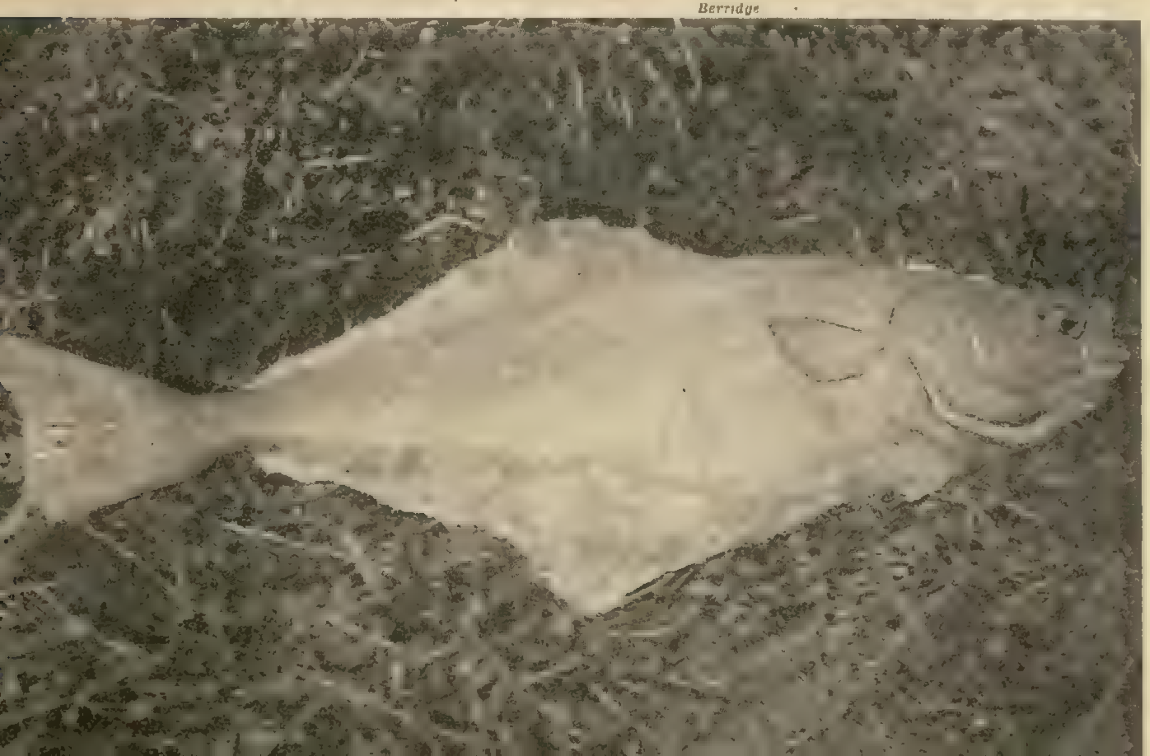
THE fourth group of the flat-fish comprises the turbot, the brill, the megrim, the scald-fish and the topknots. Of these the turbot is far the most important, rivalling the sole for delicacy of flavour, and being one of the most marketable of sea-fish. Turbot live in relatively shallow water, being rarely taken from a depth of over forty fathoms, but in spite of this they grow to a large size, attaining a weight of from twenty-five to thirty pounds. This generous growth is due in part to the turbot's diet, for it is a voracious fish, feeding off its smaller brethren, dabs, flounders, sand eels, and soles, whereas the smaller and more sluggish Pleuronectids feed mainly on cockles and mussels. The turbot is found in the English Channel and the North Sea, but it is most usually caught in the more southern fishing grounds. The brill is similar to the turbot, but is of smaller size, attaining a length of two feet, the record turbot being three feet, and it has no blunt spines on its back as has the turbot. It has a distribution similar to the turbot's, but is not nearly so prolific, since the female lays in a year about 825,000 eggs, as compared with the turbot's output of from five to ten million eggs annually. The chief interest to the zoologist of the turbot and its cousins lies in the fact that the eyes are twisted round to the left side instead of the right, as is the case with the other Pleuronectids.

Of this last group the only other member of any importance is the megrim, a deep-water fish found in all the British waters. It is not nearly as good a table fish as its near relatives the turbot and the brill, as it is dry and relatively tasteless. It is necessary to be on the look-out for it in fish shops, where it is often sold to the unsuspecting as white sole and even as lemon sole.

LARGEST OF THE FLAT-FISH

The halibut is another of our large flat-fish, but one that belongs to a different group from the turbot. This photograph shows its semi-flattened shape and the closer resemblance that it bears to the more ordinary symmetrical fish.

Berridge



BRITAIN'S ONLY POISONOUS SNAKE

FORTUNATELY for the rambling multitude, there is only one poisonous snake to be found in a wild state in our homeland—the viper or adder, as it is variously styled. It is obviously greatly to be desired that everyone should be able to distinguish an adder from either of its harmless relatives, the grass or the smooth snake; and below, in addition to a number of interesting details of its ways, its distinguishing characteristics are plainly set forth so as to make identification an easy matter

As was mentioned in the chapter in this series dealing with the British reptiles as a whole (page 225), there is only one poisonous British snake—the adder or viper. Some confusion seems to have been caused in the minds of those unacquainted with the Natural History of our country by the fact that this snake has two names, both common, and as it is frequently confused with the completely harmless grass snake, it is sometimes believed that there are three dangerously poisonous snakes that rove the countryside ready to attack the unwary rambler.

There are a very large number of adders to be found if they are looked for in the right habitat or even in the district where such habitats may be discovered. But even if the rambler does happen to stumble over a tuft of grass where an adder may lie hidden, there is no reason to suppose that he will be bitten—in fact, the chances are very much against it. The number of cases of snake-bite in Britain is extremely small, and very few of these have a fatal result. Indeed, medical evidence goes to show that more people die in this country from septicaemia following gnat-bites than are ever bitten by snakes.

It seems impossible, to anyone who knows anything about snakes, that a grass snake should ever be mistaken for an adder or that the adder should not be recognized at a glance. The adder is quite distinct from both the grass snake and the smooth snake, for instead of being long and gracefully tapered, its body is short and thick and the tail is markedly shorter. As to length, the adder is considerably shorter than the grass snake, being usually about 2 feet in the male, and perhaps as much as 2 feet 4 inches in the female. The smooth snake, although of completely different coloration, is roughly about the same size as the adder, while the grass snake, the largest British species, may sometimes be as much as 4 feet in length. The head of the adder, owing to the presence of the poison glands on either side, is broader than the heads of the other two snakes, and is quite distinct from the rest of the body. The shields, or "scales," on the head are also much smaller than the corresponding shields of either the grass snake or the smooth snake. The eye of the adder has a coppery-red coloration, and nocturnal hunting habits are suggested by the vertical pupil, for in all vertebrate animals this feature usually denotes the habit of hunting by night and sleeping by day.

Coloration of the Adder

MALE adders are brown, red-brown, and sometimes even olive, with black markings; in some grey or whitish males there are brown or black markings and the underside of the body is also black. Whichever coloration the male may have, his throat is always darker, though it is sometimes slightly spotted with grey. The females, if tending to red coloration, have dark-brown markings, while those that are olive have bright-red bands or spots. The chin and throat are also sometimes tinged with red, while the eyes are much smaller than those of the males.

The difficulty in recognizing the adder as a dangerous snake seems to be due to the fact that the markings are

CONTRASTED REPTILES

In the centre of this reptilian trio is an adder or viper; on the right is a grass snake, while the creature on the left—the slow worm—is not a snake, as might be supposed, but a lizard. Note the adder's characteristic zig-zag marking or series of spots.

John Kearton

G. Hearn

VIPER COILS

This pair of adders displays the general appearance of Britain's only poisonous snake. Distinctive though the markings may appear, a surer identification mark is the adder's broad, easily distinguished head. The female (right) shows, in turning, the characteristic broad scales of the under-surface.

subject to such a great deal of variation and, too, that the actual ground colour of the body may vary between almost brick-red and bright grey. The usual wavy or zigzag line down the centre of the back, which has a number of spots along either side of it, may sometimes not be a line at all, but a series of oval spots, while the V mark on the head may even take the form of an X. The broad shields covering the under-surface of the reptile may be anything from grey, brown or blue to black, and are sometimes spotted with yellow or orange, while the under-surface of the tip of the tail is nearly always of an orange shade. Naturalists have recorded specimens that are almost entirely black and others almost entirely olive, so that the amateur, in attempting to identify a snake that he has found, would do well to rely not on the markings, but rather on the shape of the head and the size and arrangement of the scales around the jaws.

A favourite habitat of the viper is a sandy heath or a dry moor, while the reptile also has a great liking for the sunny slopes of hills and those windless corners in the hedgerow where the sun may penetrate, bringing with it its maximum amount of warmth and yet not too much revealing light. The food of the adder consists for the most part of small mammals, such as mice, voles and even young weasels, while birds (if they are slow enough to be caught), other reptiles and large slugs are also eaten in great quantities.

With the coming of autumn the adder retires to a sleeping place for the winter, one of the favourite situations being under a pile of faggots or even a heap of manure, where the natural warmth of the decaying vegetable matter provides it with a form of central heating. As soon as spring arrives and the sun begins to warm the ground a little, the adders reappear and sun themselves wherever opportunity offers. At this period they are particularly easy to approach and handle, for they seem to be still in a state of coma and are much more intent on warming themselves than on looking for prey or watching against the advance of a possible enemy. As soon as summer comes, however, they go out into their natural haunts and live their normal lives, hunting for food in the twilight and in the very early morning, and sleeping throughout the warm hours of the day.

It is now that they pair. The young appear in either August or September and number from five to as many as twenty. The eggs are retained inside the mother until the embryos are almost fully developed, the young appearing wrapped in strings of parchment-like eggs which are broken as soon as they come into the world. Sometimes, as stated in page 228, adders are truly viviparous. The baby adders are about 7 inches long and are completely independent of their parents, going forth at once into the world by themselves and subsisting on insects and worms until their hunting ability becomes sufficient for them to catch larger prey. The old legend that the mother viper affords sanctuary to her young in time of danger by swallowing them alive is, it need hardly be said, unsupported by modern naturalists.

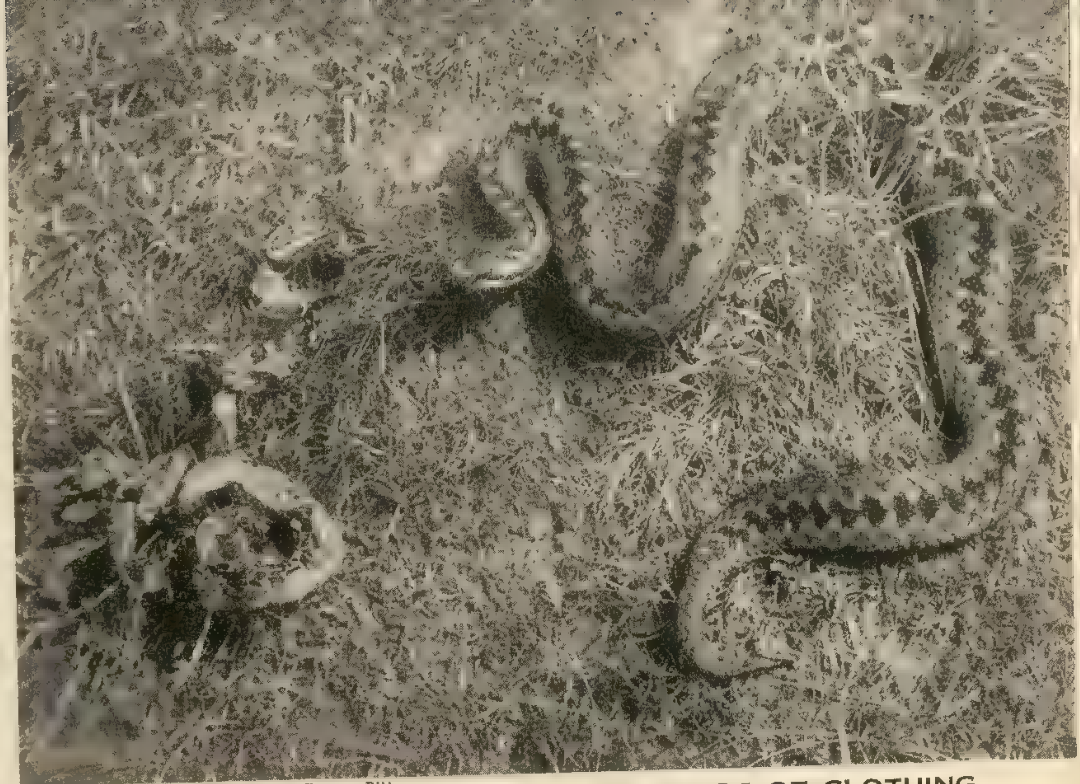
Flexibility of the Snake's Skin

Much of especial interest to the amateur naturalist is found in the physiology and general anatomy of the adder. The skin of any reptile is a fascinating and conspicuous covering; it is a dry, horny epidermis and, unlike that of any other animal, is without any form of gland which would give it flexibility. In order to overcome the stiffness which would otherwise result from this dryness the skin is subdivided into a large number of scales, these varying considerably in size in different reptiles. A high degree of flexibility is attained by the

HOW THE ADDER SWIMS

Adders are good swimmers, and will often enter the water of stream or lake when in pursuit of their prey. Sometimes on the Scottish lochs they may be seen swimming from one island to another in search of a fresh habitat.

G. Hearn



Frances Pitt

CHANGE OF CLOTHING

The large adder in this photograph has just completed the process of casting its skin, or "sloughing," which usually takes place from three to four times a year—though on this point there is much diversity of opinion among naturalists, some believing that the reptile "sloughs" only once in a twelvemonth. All the markings of the old skin are recorded on the new one lying beneath it.

overlapping of these scales, so that, when the animal moves about, the scales slide and do not interfere with the folding or stretching of the skin. They are composed of plates of skin which have been "cornified," or hardened, and each individual scale is backed with a toughened portion of the under-skin, or "dermis." The whole skin covering of the body is shed from time to time, in order to allow for change in size.

The alimentary canal of the snake is not essentially different from that of any other vertebrate, except for the fact that the oesophagus, or gullet, is capable, like the jaws, of being stretched to an enormous extent. In order to keep the mouth moist the cavity is supplied with a number of glands which secrete a special fluid into it. In poisonous snakes these glands, known as the parotid glands, have been adapted to secrete a poison which may be injected into any foe by means of the fangs. In order to make sure that this injection of the poison is carried out in the most efficient manner possible, a very special apparatus has been evolved by which the fangs may be raised and pointed outwards as soon as the mouth is opened before striking. The fang itself is actually mounted on the maxillary bone of the upper jaw, there being no other teeth of a functional nature. This bone is suspended from the skull by a hinged joint at the top end, so that the teeth are capable of swinging freely backwards and forwards inside the mouth. Right at the other end of the skull there is another bone which can also swing in a similar manner, and these two are joined together by a long, slender strut of bone known as the *pterygoid*, with the result that the two bones move together in harmony. When the muscles of the head act upon the jawbone to close the mouth, the bone at the rear of the head swings backwards, so that it lies almost in a line with the spinal column, and the teeth fixed to the bone in front are therefore forced back so as to lie in a similar position inside the mouth, tucked completely out of harm's way. As soon as the mouth is opened, however, the bone at the back of the head swings forward, and, the maxilla moving in harmony, the poisoned fangs swing in a similar direction and are raised ready for striking.

Details of the Poison Apparatus

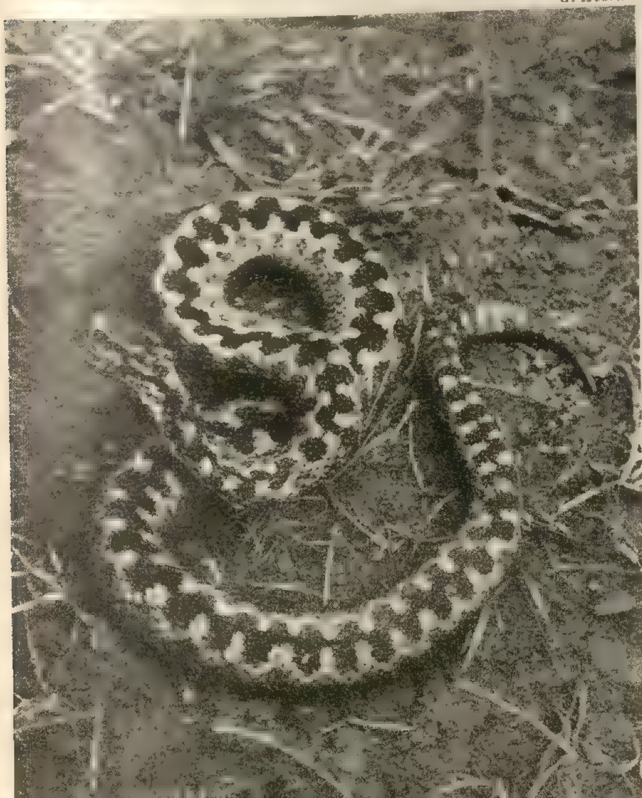
As described in the general chapter on reptiles (page 226), the true poison fang is in the form of a hollow tube, down which the poison from the parotid glands at each side of the head is forced by the action of the jaw muscles. The base of the fang itself is enclosed in a sheath of soft tissue, and this is connected in turn with the duct of the poison gland. Thus the whole apparatus forms a complete and efficient means by which the poison may be rapidly injected into the victim.

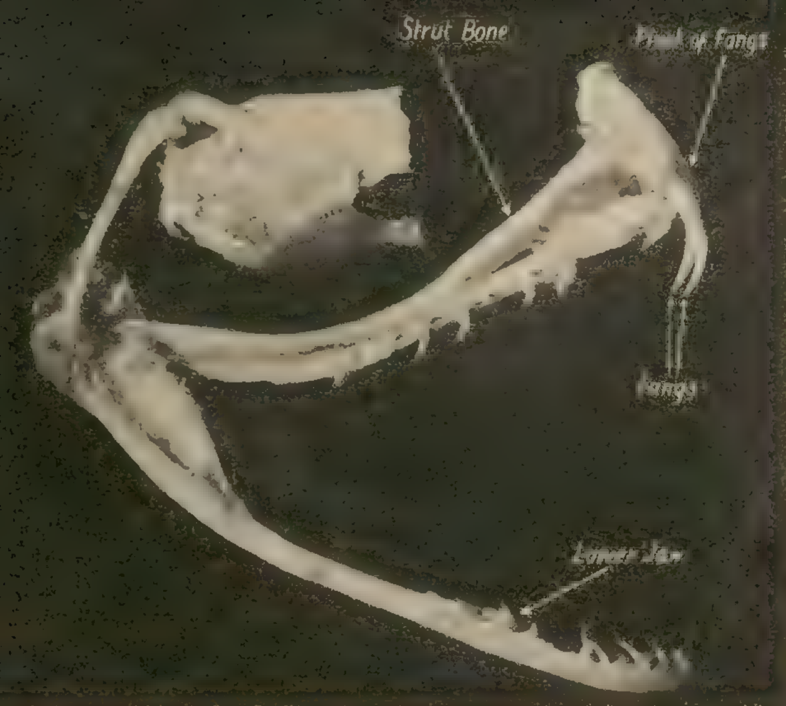
The poison fangs themselves, being very slender and hollow, are liable to injury, but the snake is prepared for this. Behind each fang there are to be found a whole series of young fangs ready to replace the others if they should happen to get broken. It is not, however, necessary

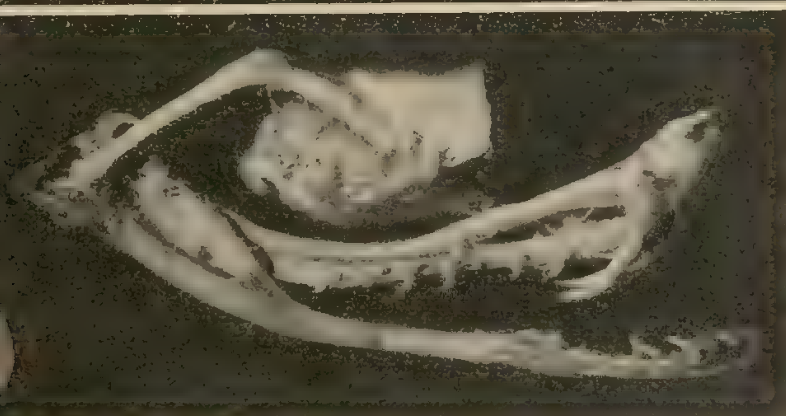
READY TO STRIKE

The viper is naturally shy of Man, but when trodden on or otherwise threatened or enraged will not hesitate to retaliate by striking with its poison fangs. The bite is painful and even dangerous to persons in indifferent health and to children.

G. Hearn







HOW THE FANGS WORK

The picture above shows an adder with the jaws opened to reveal the poisonous fangs, shown in more detail in the two small insets. In the two photographs on the left the bony apparatus by which the fangs are raised and lowered is clearly depi

for the large fangs to be broken or damaged in any way before replacement occurs, for the fangs automatically drop out at regular intervals, their successors growing up behind them within a few weeks.

As regards the distribution of adders in Britain it should be noted that the adder is particularly fond of heat, though not necessarily of an entirely dry heat, and is to be found under warm damp bracken just as much as beneath dry heather. On the downs adders generally go into hiding during the very hot hours of a fine day, and in parts of Kent and Devon and all along the south coast they seem to shelter themselves under gorse bushes or in any other shady place. Like most of our other reptiles, they are to be found throughout Britain, but not in Ireland.

THE adder does not thrive in captivity as do the other two British snakes. It is by no means an amiable reptile, and often displays bad temper by refusing food and drink. Its temperament might be described as sulky, and most captive adders die in the end of starvation, a "hunger strike" being their method of protesting against the deprivation of their liberty. On being captured the adder always shows fight and is ready to bite, but in a state of freedom it is by no means an aggressive animal. It seems to depend largely upon its ability to take cover and escape observation, and in doing this it makes full use of its colouring as camouflage.

HOW TO TREAT AN ADDER-BITE

The adder strikes in self-defence. It will not deliberately attack unless it is in some situation from which it cannot escape.

The adder's bite is dangerous only to very young or weakly persons, but it is likely in every case to cause considerable pain and distress. An intense burning pain may be felt at once at the site of the wound, but this does not always occur, and the first warning that a person has been bitten may be his showing the general signs of poisoning. These are faintness, a cold perspiration over the body, sickness, and perhaps diarrhoea; sometimes unconsciousness.

In the first place it is essential to prevent the poison from getting into the general circulation. To this end the flow of blood and lymph from the affected limb may be stopped by a tight ligature applied above the wound. The first thing to do, therefore, is to roll up a handkerchief or something of the kind and tie it tightly round the limb, above the bite, so as to stop the circulation. The tourniquet illustrated is improvised with a stone placed in a bandage knotted round the arm, after which a stick is pushed through the loop and twisted.

This photograph shows a form of tourniquet that may be applied in cases of snake-bite.

The wound should next be sucked thoroughly so as to extract the poison. There is no danger in doing this provided there are no cuts or abrasions of the lips or the lining of the mouth and the poison is spat out. When the wound has been sucked white the mouth may be rinsed with water, or with a little spirits.

The ligature should be taken off when the wound has been thoroughly cleansed, and in any case must not be left on for longer than half an hour. If weak ammonia or a solution of permanganate of potash can be obtained, either may be used to wash the wound. If the bite is severe the wound should be cut open with a knife, sterilized by immersion in boiling water or by passing it through a flame, and permanganate crystals pressed into it.

The patient must be kept warm by covering with extra clothing and by chafing the limbs. If spirits are available, a little should be given at frequent intervals. Sal volatile will be an equally good stimulant, or hot tea or coffee. The patient should be reassured as to the outcome of the accident.

In order to neutralize the poison in the system, 100 cubic centimetres of antivenine may be injected intravenously.

SWARMING HORDES OF BRIGHT-WINGED INVADERS

THE butterflies described in the following chapter—the clouded yellows and the marbled white—introduce us to the entomological phenomenon of "swarming," a subject which, despite long and persistent investigation, still receives a large measure of attention. All three butterflies are reproduced in the colour plate facing page 36 (Figs. 4, 11, 19 and 6)

OF all the butterflies that are subject to periodic increase followed by almost complete absence, the most notable in the British Isles is the clouded yellow. This butterfly, which, with its near relative, the pale clouded yellow, completes the members of the White family to be described in this work, is seen in some springs in enormous numbers and in others is almost entirely absent from even its most regular haunts. The reason for this, according to many leading entomologists, is that in many of its European haunts it is able to produce three or even four broods in the course of a single season, each successive brood being of larger dimensions than the last. The final brood is forced to seek new feeding and breeding grounds, or, in the terms of the scientist, to

A. E. Tonge

JUST DEPOSITED

The batch of eggs (above, enlarged 13 times) of the clouded yellow butterfly are newly laid, for their pale colour changes when they are approaching the time of hatching. They show a family likeness to those of the Large White butterfly, illustrated in page 38, both insects being members of the same group.

extend its range. Successive waves of adult insects then pass over Europe, and some of these, usually in the spring, reach our shores, where they often succeed in establishing themselves, for a few generations at least. In the autumn of the same year appears the numerous progeny of the visitors, and if the conditions are suitable throughout the winter, there will be a still larger stock in the following spring. At the same time, further waves from abroad may invade the southern coasts, and this process may go on for as many as five years in succession, every successive year seeing a greater number of the insects. Then, suddenly, a point is reached where some external factor intervenes—there may be an especially sharp early frost, a long, hard winter, or some epidemic of disease or of parasitism—and the insects will vanish. For perhaps five years they will be scarce, and alarms of their extinction may be raised: then, in the same mysterious manner, the swarms begin again.

THIS cycle of increasing numbers of insects is, of course, a phenomenon well known to professional entomologists. To its operation may be put down the devastating swarms of locusts, the masses of caterpillars which from time to time defoliate the trees in the London parks, the sudden plagues of cockchafers that work havoc in our gardens. There is, however, no insect in which it is so noticeable, to the eyes of the uninformed town- or country-dweller, as the clouded yellow, on account of the butterfly's fine and conspicuous colouring.

The orange ground-colour of the fore-wings and the even more brilliant yellows of the underside long ago earned for their wearer the names of the "Saffron" and "Spotted Saffron," and the butterfly was known to the earliest writers on the subject in this country. The male insect has the inner areas of both fore- and hind-wings entirely orange, although the latter are suffused with a brownish powdering. In some cases this powdering, when seen in certain lights, gives the insect a wonderful blue sheen, and the orange may vary to quite pale yellow. In both sexes there is a black spot in the fore-wings and a round orange spot, which varies greatly in size, in the middle of the hind wings. The wings are bordered with

EGGS OF UNUSUAL FORM

Most butterfly eggs conform to a certain type, being usually upright, and ribbed, but those of the marbled white butterfly shown below are notable exceptions. They are actually covered with an extremely fine network, too fine to be visible except under very high magnification. The eggs seen below are × 13.

A. E. Tonge

BUTTERFLIES-IN-WAITING

Above are shown the pupae of (left) clouded yellow and (right) marbled white butterflies. Representative of two of the larger groups of butterflies, they differ in some important points, notably in the fact that the one is attached to the food plant while the other lies loose on the ground. Twice natural size

black in both sexes, but in the female this border is broken by a number of yellow or orange spots, which vary in size and number in individual specimens. The underside of both sexes is a brilliant saffron yellow. The black spot of the fore-wings is repeated, but the orange patch of the hind wings is replaced by two clear, silvery spots, one very much smaller than the other. The central area of the fore-wings is suffused with orange, and there are a few brownish spots near the wing margin.

As has been indicated, this butterfly is often seen in the early part of the year, but it is during the months of August and September that it is most frequent. Then the place in which to seek it is the clover or lucerne field, where sometimes the butterflies will be so numerous as to make a yellow haze as they flit to and fro over the flowers, the females stopping from time to time to lay their eggs on the leaves; any of the near relatives of the clovers are used as food plants. The clouded yellow is one of the easiest butterflies to rear in captivity. A female caught on the wing in autumn may be enclosed in a glass jar with a growing clover plant, and a fair batch of eggs may, in due course, be procured.

CATERPILLARS IN CLOVER

Green in colour, their uniformity relieved by a pale yellow line along the sides, the caterpillars of the clouded yellow butterfly are hard to see among the leaves of their food plant, which may be (as in this photograph) one of the many species of clover. The caterpillars shown here are twice natural size.

A. E. Tonge

In many cases, if it happens to be a year in which these insects are at the height of one of their periods of increase, a number of the females will be found to have the orange colour replaced by a very much paler yellow. These constitute a variety well-known to the collector, and by breeding from a female of this type and crossing the offspring with a normal male a very interesting and complete series from orange to yellow may be obtained.

The egg of the clouded yellow is of the ribbed type common to most butterflies, much tapered at both ends. The caterpillars are brownish when they hatch, but soon become green, and, when full grown, are green powdered with minute black dots, and have a yellowish line along either side. They may be found, in a year when the insect is common, in June, and again in September and October. The winter is passed in the pupal stage, the chrysalis being yellow-green, darker above than below, with black dots on the body and the edges of the wing covers. A beaked projection in front of the head is present as in the other members of this group.

The Rarer Clouded Yellow

THE pale clouded yellow is a very much scarcer insect than that described above. The general colour (as may be seen from Fig. 19 on the plate facing page 36) is lighter and purer, and the black margins to the wings are more confined to the fore corner, where they are interrupted by a yellow band. In the female the margins are wider, being present in the hind wings as a series of patches. In the female, also, the orange spot of the hind wings appears as two small spots. The underside is similar in general scheme to that of the clouded yellow, but in the female the inner area of the fore-wings is of an almost whitish-green colour. The whole butterfly is much less

robust in appearance and the wings are edged with pinkish ; the antennae are pink.

The same periodicity mentioned above applies to the pale clouded yellow ; this insect, however, passes the winter in the larval stage, an important factor when its distribution is considered. Whereas the clouded yellow pupae can easily pass the winter in this country, that season seems always to be too severe for the majority of the caterpillars of the more delicate insect, and few ever survive to carry on the race in the following spring.

Erratic Visitant to Our Shores

EVEN where a colony is founded, the first hard winter will wipe it out. A glance at the records of entomologists over a long period shows that the insect has never been really common in this country, and its visits have been most erratic. In any summer when the clouded yellow is common, however, we may see a few pale clouded yellows, for they frequent the same haunts, and in some years are found in large numbers in isolated districts.

In the height of summer, in rough country, on the edges of woods, on the downs, and on grassy slopes generally, one may often see very large numbers of another butterfly which is prone to a periodicity almost

REST AFTER FLIGHT

Sitting, with its wings closed, on the flowers of one of the downland grasses, this clouded yellow butterfly has taken up an ideal pose for the camera man. The pure colour of the undersides of the wings is relieved by a single spot of brilliant silver ; sometimes there is another (very small) spot. (× 2)

J. J. Ward

J. J. Ward

COLLECTOR'S PRIZE

Though in some seasons it is very common, the clouded yellow is a great prize so far as young collectors are concerned, as its speed makes it difficult to net. The absence of yellow spots on the wing margins shows that this is a male insect, in contrast to the female shown in page 319. This photo is twice natural size.

as marked as that of the clouded yellow. This butterfly, the marbled white, is one of the most unmistakable of all our insects ; the fore- and hind-wings are beautifully chequered with large patches of black and creamy white, those of the latter colour forming a rough band across the rear part of the fore-wings, and the hind wings. These markings are only faintly reproduced on the undersides, where a brownish or greyish tinge is often found instead of black. Small eye-spots are also found on the hind wings in place of the black patches that appear on the upper surface. This colour scheme (*see* Fig. 6 in the plate facing p. 36) was responsible for the old names of "Marmoress" and "Half-Mourner" for this butterfly.

THERE is a great deal of variation in the wing-markings of the marbled white, for a complete range of varieties has at one time or another been found from almost entirely black to the opposite extreme, in which the whole insect is of a clear creamy-white. In general the female is a larger insect with more white than the male.

The egg of the marbled white is of interest, since it differs considerably from that of the species that we have previously described. Whitish in colour, and, opaque, it is rather like a short, broad vase in shape,

S. C. Johnson

'HALF-MOURNER'

At rest upon a pale leaf, the marbled white butterfly shows us the fine contrasting colours that earned for it the curious old name of "Half-mourner," while their arrangement in a marbled pattern is responsible for the present name and for that of "Marmoress," *marmor* being the Latin for marble. ($\times 1\frac{3}{4}$.)

broadest near the bottom, flattened on top, with a dark speck at the apex. The base is slightly hollowed. These eggs are covered with very, very fine reticulated markings, but the ribs that are so characteristic a feature of the eggs, say, of the Large White and Small Tortoiseshell butterflies, illustrated in pages 38 and 234 respectively, are noticeably absent. These eggs, moreover, are not laid on the food plant, but appear to be dropped at random among the downland grasses. They are laid in July.

The caterpillar, which feeds on various grasses, is of a whitish-brown colour, with a number of fine brown lines along the back and sides; the whole body is covered with fine hairs. An interesting point is that the caterpillar does not appear to make any effort to choose a special site for pupation, but merely turns into a chrysalis in the thick herbage or moss at the base of the plants on which it has been feeding.

Periodicity of the Marbled White

As has been said, the marbled white is subject to periodic abundance, but this is probably of a different type from that found in the clouded yellows. It is a truly resident butterfly, living easily through the winter as a very small caterpillar, and there seems no need of waves of insects from the continent to cause these irruptions. There is no doubt, however, that in some years marbled whites are seen in enormous numbers, especially on the chalk downs of the south of England, whereas in other years they are really quite scarce in their favourite localities.

In the case of many butterflies in which there is considerable variation, one must usually wait until one of these years of abundance before being able to select specimens to give a good range, but the marbled white often provides us with an opportunity to avoid this. This is due to the fact that the butterfly is at all times rather inclined to live in little colonies, so that when we find a single insect, we are likely to find more, near at hand. A series can then be netted, boxed in glass-topped pill-boxes, and examined on the spot. Those that are required for addition to the collection may be bottled at once, the others liberated; thus not a single unnecessary death need occur in the colony. Of course, we may find that whereas all the specimens of one colony show a decided range of variation in one particular direction, those from another colony hardly vary at all, or vary in the opposite direction, being, say, lighter than the norm, instead of darker. This is the sort of opportunity for which the true enthusiast longs, for it gives him a chance of doing some original research. What are the conditions in the two colonies? Are the food plants of the caterpillars the same in both cases? Do the adults appear at the same time of year? Is the soil different? Is it wet in one place, dry in another? All these are questions that should be asked and answered to our own satisfaction. Then, too, we may take home some females from each colony, and try to induce them to lay eggs, being careful, of course, to keep the resulting larvae on the same food plant as we found in the colony. Failing this, we may search and find larvae or pupae actually *in situ*, and bring them home and rear them, then breed from them, perhaps feeding the next generation on food from the other colony, perhaps crossing the adults with those bred from the other colony. Thus, from a few, perhaps casual

BLACK AND WHITE

Although the brilliant black and white of the marbled white might be expected to give it away when at rest, it is surprisingly successful as a protective colour scheme, especially in bright sunlight. A comparison of this photograph with that above gives some idea of the variation which is common in this species (Slightly more than natural size.)

C. F. Metcalfe

THE TWO CLOUDED YELLOWS, PALE AND COMMON

These three photographs show (left) the pale clouded yellow butterfly; (centre), the underside of the same insect; and (right), the female of the clouded yellow. The pale clouded yellow is a much scarcer insect than the other and is easily distinguished by the lighter colour of both upper and under sides of the wings. On the underside, which may be compared with the lower picture in page 317, the spots are more noticeable. The yellow markings on the wing-margins of the clouded yellow vary greatly, but those shown in the above specimen are typical. All three insects are shown about natural size.

observations on the marbled white, we may find ourselves in the midst of fascinating and original research—research, moreover, that is on the most important lines of all, for this is research in the field of evolution, the solution of whose mysteries is a worthy prize for any entomologist. This butterfly is not a relative of the other Whites, but is a member of a part of the great family which includes the Vanessids, already dealt with (*see* page 232), and a number of other common insects which are described in later chapters.

The sub-family to which these last belong is that known as the Satyrinae, and we have eleven native species all of which are fairly common, though several are certainly local in their distribution. They include such well-known insects as the meadow brown, the grayling of the heaths and chalk downs, the gate-keeper or small meadow brown, and the large and small heaths. The marbled white, however, differs from all the other members of the sub-family in its colouring, which is black and white instead of simple browns.

COLLECTING BUTTERFLIES. 3

Mention has been made in the "practical notes" in pages 42 and 114 of the apparatus needed by the butterfly and moth collector and some of the necessary equipment is illustrated on the right.

The net frame is of three-jointed type, so that it can be easily folded up and put into the pocket. The joints consist of brass cylinders which run one inside the other, and one has only to hold the frame and pull, and the two will come apart. The framework between these joints is made of cane. The ends of the frame are brass, square in section so as to fit into the brass arms of the Y-piece, which is here shown attached. This Y-piece has a hollow stem, and can therefore be used either as a handle or can be fitted over the end of a stick, which makes a longer handle. Many experts prefer the short handle, which gives more control over the net, at the risk of losing a few insects that are out of reach of the longer sweep that can be made with a wooden handle.

Killing the Catch

The killing bottle, here shown empty, is of the type with a cork; another type has a metal screw-top. The wide mouth to the bottle should be noted; although any bottle with an air-tight stopper may be used, there is no doubt that it pays to have a wide-mouthed one. Cyanide of potassium is best used in one of these bottles, the mixture being made up with plaster-of-Paris by a properly qualified chemist.

A whole series of pill-boxes, with glass tops, is also shown. These are what are known as "nested," because they are of carefully-graded sizes, so that each one will fit into the next. In these are boxed insects required to be taken home alive.

Often the catch is killed within a few minutes of capture (as indeed it should be if the killing bottle is of proper strength), and then comes the turn of the collecting box shown on the left. Both the base and the lid are lined with cork, and the box is airtight, the hinged lid fitting closely so that there is no danger of its coming open suddenly. When the insects in the killing bottle are dead, they are taken out (with the forceps shown here lying in front of the bottle) or tipped out into the hand, and carefully pinned and put in the box. For pinning insects, proper entomological pins, which are long and fine and have small heads, must be used.

As to setting the insects, this is done on a proper setting board, which may be either of the type shown (to the left, standing upright) or, preferably, of convex type.

For arranging the wings use a setting needle of the type shown. Some collectors prefer a bristle, similarly fixed. The set of folding magnifying glasses forms the final article of the beginner's equipment

FOR THE COLLECTOR

This photograph shows the apparatus which the collector of butterflies and moths will need if he is to be reasonably well-equipped. The frame only of the net is pictured here, in order to enable the joints by which it is folded to be easily seen.

Apparatus supplied by Messrs. Watkins & Doncaster

THREE MEMBERS OF THE FINCH FAMILY

FOUND almost everywhere throughout the British Isles, the finches are amongst the most popular and easily recognized of our birds. In the chapter below bullfinches, greenfinches and goldfinches are described and compared; the chaffinch, the remaining member of the finch quartet, is dealt with in Chapter 11 of this series (page 329). Each of the finches is quite distinctive in appearance—a fact that is made manifest by the photographs accompanying the text in this and following pages

DECORATIVE, attractive alike in appearance and in song, useful to the arable farmer and partial to such haunts as gardens and roadside hedges, the finches are amongst our best-known and most popular birds. Four species are really common all over England, namely, the chaffinch, greenfinch, goldfinch and bullfinch; of these the last three will be dealt with in the present chapter, the chaffinch being reserved for the next (page 329). Although in habits these birds are all very similar, they are absolutely distinct in appearance, and vie with each other in presenting a blaze of colour to our eyes. In character, too, they are very different. The greenfinch seems essentially the family man—rather lazy, full of good food, amiable and prosperous; the chaffinch is somewhat similar, but, as it were, on a slightly lower social scale—busier, more hard-working, neater. The goldfinch is the dandy of the tribe, and a dandy of parts, for he charms us with his melodious song, his delightful habits and his incessant activity. Finally, the bullfinch, a bird that is on an altogether different social scale. Handsome to a degree, well-built, rather less fond of the haunts of Man, he has in his make-up much that reminds us of the blackbird; there is the same proud bearing, the same conceit when one sees him with his plain little spouse, and he has, moreover, the same appetite for fruit, which makes him the sworn enemy of the market-gardener and the fruit-grower.

Our first subject in the present chapter, the greenfinch, is a bird whose beauty often passes unappreciated, even among those who know our birds well. To most people the greenfinch is just a rather insignificant green bird, which is seen in the garden in the summer and nests among the ivy of the big trees or in the thick hedges that surround the garden. The male bird, however, is far from dull if he is seen preening himself in the sun, when the full beauty of his plumage can be appreciated. The general colour of his feathers is brilliant yellow-green, with greyish colour on head, belly and sides. The wings, which have blackish primaries, are otherwise greyish, with a brilliant yellow edge. The base of the slightly forked tail is also bright yellow, and when the bird flies these features surprise us with their colour.

GREEN TWITTERER

One of our commonest finches, and one of the least showy, the greenfinch can none the less surprise us with a brilliant flash of yellow on his wing, just visible in this photograph. The song is a not very distinguished twittering, but the long *weee* is one of the familiar sounds of summer days.

W. S. Berridge

Beaks that Serve the Finches Well

AS regards its general structure, the greenfinch may be taken as typical of the large family of the *Fringillidae*, which includes the finches and the buntings. The distinguishing feature of the members of this family is the beak, which is short and hard, so that when closed it makes a little sharply-pointed cone, admirably adapted to the cracking and opening of fruits and the crushing of the seeds on which the birds feed. In general build they are short and stocky, often with brilliant plumage and not very strong flight. They are essentially birds of the hedges and woodlands and bushy places, and are members of the great order *Passeriformes*.

Greenfinches are rather sociable little birds, and several pairs are often found nesting near each other in a thick hedge or among the bushes of a big shrubbery. The nest is a somewhat loose affair, made of twigs, grasses and moss, sometimes with a little wool as well. Wool may also be used in the lining, which, however, is more usually made of hair and feathers. The flat branches of the conifers that are often planted in large gardens are favourite nesting sites. The eggs are cream-coloured, sometimes white, with a number of red, brown or purple spots and blotches towards the larger end. It is worth noticing that whereas in the tits the spots and specks are quite well-defined and hard round the edges, in the finches they are often rather soft and dull, as if the colour had run.

The song of the greenfinch, though to many people scarcely worthy of the name, is without doubt one of the really pleasant sounds of summer. It consists of a single note, a long-drawn-out *weee*, a sound that is

C. Reid

GOLDFINCHES AT HOME

This neat nest in a clump of bamboos is typical of the goldfinch, although the site chosen is unusually exposed. The handsome colour scheme of the birds cannot, of course, be rendered in a photograph, but the contrast of light and dark on the head can be realized, if only in part.

so completely in tune with the hot, still days of June and July that no one who has had a bevy of greenfinches in his garden will ever wish to be without their company in summertime.

Known to many town-dwellers as a charming and amusing cage-bird, the goldfinch is still not so common in the wild state as it was in former years, but it is gratifying to notice that this lovely little finch is gradually becoming more and more widely distributed throughout the country. So striking is its plumage that little description of it is needed. The head is banded, from the beak backwards, with scarlet, white and pitch-black, of which colours the white makes a ring round the chin, while the black is confined to the upper part of the head. The upper parts of the bird are rich brown, shading gradually into white beneath, while across the black wings there is the brilliant golden band which gives the bird its name; the wing feathers are also tipped with white. The tail is black spotted with white above, and white below.

Other Names for the Goldfinch

The goldfinch has many nicknames, all connected with its fine plumage, such as knicker, red linnet (the greenfinch is sometimes called the green linnet), sheriff's man and seven-coloured linnet. In winter when flocks of these birds are feeding on the dead heads of such plants as knapweeds and thistles, or on the great sunflower heads that are put out for them in the garden, they make a most engaging picture, twittering to and fro and flitting gaily from plant to plant in a way that is very reminiscent of the tits. A "charm" of goldfinches, as a small flock is called, often consorts with the other finches in the rickyard or in the fields where a stack has been threshed, for goldfinches are great seed-eaters, and, in common with other members of their tribe, are of considerable value to the farmer in keeping down the growth of noxious weeds, especially thistles.

In its nest the goldfinch is sadly disappointing. Not that it is not a rather fine nest, being a closely-woven structure of roots and grasses, consolidated with moss and lichen, and lined with wool and thistledown, but the goldfinch is extremely dirty in its home-life, and the edge of the nest is as often as not quite encrusted with droppings and débris that a cleaner bird would have carefully removed. The eggs, usually four or five in number, are bluish, spotted with dark brown or purple. Those found quite late in summer are probably a second brood. The song of the goldfinch is best described as a

SEED HUNTING

Like all finches, the goldfinch is partial to flower-seeds, and this smart fellow, perched tit-like on the thistle head, is evidently in search of a meal. Its fondness for weed-seeds gives the goldfinch a place among the farmer's friends, while its beauty makes it a firm favourite with the rambler in the country.

R. C. Hinkins

Ian M. Thomson

GROWING UP

These young bullfinches are full-fledged, and one of them shows his growing sense of independence by sitting on the edge of the nest. Perhaps this is just as well, for there is little room in the home now for such large youngsters, especially when their parents want to sit down!

continuous and very melodious twittering; often uttered by a number of birds in chorus, it may then be one of the most welcome of all our summer songs, for not many of our birds combine beauty with musical gifts in the way that this little finch does. Besides the diet of seeds already mentioned, the goldfinch eats large numbers of insects, especially in the spring when the flocks of unpaired birds spend much time in the larch woods and other coniferous woods, feeding on the many aphides and beetles that attack the soft green shoots.

Very different from either of the preceding species is the bullfinch. This bird combines in a remarkable fashion a shyness of disposition, which causes it to live where the hedges and bushes are thickest, with a calmness and insolence in the presence of Man that is perhaps unequalled by any other bird. In spring, when the buds are soft and green on the fruit trees and bushes, the bullfinches will descend in little parties and do enough damage to drive the anxious gardener to desperate measures. Even then the bullfinches are undismayed. They flit silently away for a few minutes, and when the gardener's back is turned return equally silently and continue the feast, until the soft, piping call again proclaims their presence. If one bullfinch of a pair is shot as they sit close together in a bush, the other will as likely as not go on feeding! Moreover, the excuse that can be used in defence of other bud-destroying birds, namely, that they are seeking the "worm i' the bud," does not apply to the bullfinch. Perhaps in order to get at the soft green leaves within, but more likely, the gardener would say, through sheer delight in destruction, the bullfinch will hop sideways the whole length of branch after branch, leaving behind it a row of bare twigs, and, on the ground, a mass of ripped-up fruit buds.

In spite of these shortcomings, however, much may be forgiven to the bullfinch, especially when it is gracious enough to show itself to us in full summer plumage.

With glossy black head, chin, secondary wing feathers and tail, and greyish underparts, even the hen bird is handsome in a quiet way. But when, in the cock, we find in addition the lovely red of the cheeks and underparts, shading to white under the tail, we have, indeed, a

Ian M. Thomson

ALL AT HOME

When the young birds are growing, it is not often that all the family are at home together, for the parents have to spend most of their time out foraging. From their serious demeanour it would almost seem that the father and mother bullfinch seen above are discussing the youngsters' future.

FOOD! FOOD!

There is no manner of doubt what is the matter with these young greenfinches: they are hungry, and are telling the fact to the world! Their mother, however, is quite unperturbed, and she cocks her head as if to intimate that the sound of her husband's song is more important than her children's appetites.

C. W. Teager

PINE-TREE VILLA *A. Brook*

Firmly founded on the flat branches of the pine tree, this bullfinches' nest has been photographed at close quarters, so that we get a clear view of the ménage at the moment when the hen bird is in the act of feeding her hungry brood.

resplendent visitor. In both sexes there is a white bar across the wings, and the rump is white. These two white patches are the most conspicuous parts in flight, and the rump especially draws attention to the bird as it flits along the hedgerows and through the bushes. The bill is shorter and stouter than in the other finches.

In summer we may expect to see the bullfinch in places where there is tall and fairly dense vegetation, such as the thickets of blackthorn that are found in badly-cultivated land in the south of England. In the woods, too, we may hear the quiet piping which is characteristic of the bird. The song, a low and simple little repetition of several notes, is uttered by both birds, and this and the call note often betray the birds' presence in a district where they are seldom seen in the open. It is a feature of bullfinches that they pair for life, and the pairs may be seen together in the same spot year after year.

Flimsy Build of the Bullfinch Nest

THE nest of the bullfinch is very different from that of either greenfinch or goldfinch, for it is often little more than a mere platform of twigs, with roots and hairs for a lining; at its best it is a shallow cup. Well-hidden in brambles, in thick bushes, in the low branches of a tree, or in such a thicket as has already been described, it is built in April or May, and the eggs, four to six in number, are greenish-blue, zoned with a number of purplish spots and markings around the larger end. A second brood is often reared.

The resident bullfinches found in England are classed by many systematic ornithologists in a special sub-species, since they appear to be non-migratory. The northern bullfinch, as the Continental form is called, is a larger bird, finer in colour and generally bulkier in build. This is the form most frequently found as a cage-bird.

It is worthy of note that the finches described in this chapter are all of great value to bird fanciers, not so much on account of their own beauty as for the fine hybrids which can be obtained by inter-breeding. They will cross quite freely in captivity, and yet it is a curious fact that there seem few well-established instances of wild hybrids being found. Those that have been reported are often considered to be the products rather of the imaginations of bird-catchers than of Nature herself!

Besides the chaffinch, there are several other closely related species found in the British Isles, these including the hawfinch and the crossbill; both of these birds are described in later chapters.

Revealers of Nature. 10

W. H. HUDSON

IF the post-war revival of interest in Nature-study can be attributed to one man more than to another, he is certainly William Henry Hudson, who, though he spent his life in poor circumstances and obscurity enlarged the vision of countless thousands through his books, especially through those on birds. The facts of his life are not of unusual interest. He was born in August, 1841, near Buenos Aires, of British parents, and until he was 33 remained in South America. He spent those years mainly on the pampas or prairies of the Argentine and Paraguay, but also travelled farther afield, ultimately becoming intimate with a great part of the South American continent.

Hudson's special interest in South America, as, later, in England, was the study of bird-life in its natural surroundings. On this aspect of Nature-study he became an acknowledged authority, but his books at first reached only a small circle, and it was not until after his death in 1922 that he became at all famous. From 1874 onwards he lived in England, mainly in London, where his wife kept a boarding-house; but by 1901 the value of his work was being recognized, and in that year he received a civil list pension. His name was first made familiar to all by the establishment in Hyde Park of a bird sanctuary dedicated to him, containing the famous mural sculpture by Epstein, representing Rima, the elfin heroine of Hudson's "Green Mansions." If the controversy which arose over "Rima" induced many to read Hudson's books for the first time, it served a useful purpose, for these books are the product of a mind of extreme sensitivity, and are full of scientifically correct detail as well as of unforgettable pen-pictures of Nature, both human and animal.

Of greatest value to the student of ornithology are Hudson's "Argentine Ornithology," "The Naturalist in La Plata," "Birds in a Village," "British Birds," "Birds in London," "Birds and Man," "Adventures Among Birds," and "The Book of a Naturalist." In these works every fact of interest and many previously unknown facts about birds are chronicled in a style which is as far removed from the dry-as-dust scientific language as Hudson was from the biologist in a laboratory. He gained a wider audience, however, for his works on the countryside in general, wherein he not only gave vivid pictures of its natural beauties, but also evinced deep sympathy with and insight into the home life of country districts and rural customs and traditions. Such books include "Nature in Downland," "Hampshire Days," which contains a delightful account of the wild life of the New Forest, "Afoot in England," and "A Shepherd's Life." "Green Mansions" is a romance, set amid the tropical beauty of the upper Orinoco, and "Far Away and Long Ago," "Idle Days in Patagonia," and "History of My Early Life" describe his early years of apprenticeship to Nature-study.

These books touch, and reveal, Nature at every point. No Nature-lover could find a better tutor than Hudson, who not only possessed a gentle and attractive personality, but also everywhere emphasized the pleasure of discovering things for oneself, and showed the reader how to do so by his own example.

VORACIOUS TIGERS OF THE INSECT WORLD

ANOTHER fascinating life story is related in this chapter—that of the dragon-fly, of which some forty species are found in Britain. Its career is divided into two unequal and widely-contrasted portions: one of some months spent as a nymph in an underwater habitat, and the other—generally enduring but a few weeks—flying at large as a full-grown insect. The successive stages, illustrated in the pages below, may well be compared with those of the butterflies dealt with under the heading "Our Butterflies and Moths"

WITH powerful, direct, darting flight the big dragon-flies hunt down weaker and less quickly-moving insects, only stopping from time to time to preen themselves on a leaf or the blade of a rush, then taking off again and cruising to and fro along the waterside. Fierce, indeed, they look in flight, and even fiercer when viewed at close quarters, when the great eyes blaze at us and we see the strong, grasping legs ever ready to seize some hapless insect. Small wonder is it, then, that they are credited by country people generally with the ability and even the will to inflict a severe sting, not only on Man, but also on domestic animals. In many parts of the country they are known as "horse-stingers," a name based on no other evidence than their somewhat fearsome appearance.

In actual fact, the dragon-fly is a very much fiercer creature in its immature stages than as an adult, although even then it is one of the greediest of insects. The young larvae live under water, and eventually, when fully grown, crawl slowly up the stem of some rush or water plant into the open air, and there hang motionless. In this stage the nymph, as it is strictly called, is a dingy, greyish-brown creature, not at all resembling the resplendent fly that it will soon become. The legs and head and jaws are all there, but the wings are represented solely by a set of small pads on the back of the thorax.

What follows may be compared with the emergence of the butterfly from its chrysalis, described in the first chapter of Our Butterflies and Moths series (page 39). As the nymph hangs on its perch, clinging firmly with the strong hooks at the ends of its legs, a sudden split takes place in the back of the thorax, through which appear the head and forepart of the adult insect. As this split lengthens, the rest of the fly's body is drawn slowly outwards from the old skin, and the creature climbs gently up the stem until it is free.

THE way in which fluids from the body flow out into the weak and crumpled wings, and stiffen and strengthen them, is exactly parallel with the case of the butterfly. In the same way the body becomes firm, and its outer shell hardens, while wings and body assume their

DRAGON OF THE AIR

Preening itself on the hedgerow leaves, this great dragon-fly is resting in the summer sun, its wings spread wide ready for instant flight. A member of the genus *Aeschna*, it shows the typical large wings and rather thick body. (About life-size.)

A. S. Mull.

J. J. Ward

FIERCE FAIRY

Delicate and fragile as this dragon-fly looks, it is none the less as fierce an insect as any of its tribe. The light build, long, thin body and dainty wings—both pairs of which are the same shape—show it to be a member of the family *Agrionidae*—which contains the smallest of our dragon-flies. (Slightly enlarged.)

true colours. The dragon-fly crawls up the stem, its wings held upright above its back, and then tries a weak, preliminary flutter to the next stem. A few such movements and it is ready to glide away, its wings making a loud flutter, in search of its first meal as an adult insect.

In the British Isles there are some forty or fifty different species of dragon-fly, many of which would probably seem exactly alike to the casual student of insect life. Several of the common ones, however, are very distinctive, and a brief description of some of these is given below.

The dragon-flies constitute the order *Odonata*, although they were at one time considered to be only a small group of the great order of *Neuroptera*, or nerve-winged insects. Within their own order they are divided into two groups, the most obvious difference between which is that the members of one group have rather flattened or stoutish bodies, while those of the other group have long, narrow bodies. The wings also differ considerably in the two groups.

Learning the Dragon-fly's Ways

FULLY to appreciate these insects it is advisable to see them in the wild state, for when they are set up in the collection it will be found extremely difficult to preserve the delicate colours, which are among their chief beauties. In the larger individuals, too, it is necessary to stuff the bodies, for they are so large as to smell unpleasantly if allowed to rot in the collecting box.

For all their great speed and strong flight many dragon-flies are easily caught in the net, and they may then be examined with ease. In spite of its terrifying aspect, and although it will make repeated efforts to bite with its powerful jaws, one may be quite safely held in the hand by grasping it by the thorax with the finger and thumb; this also prevents the wings from fluttering. The fact that, when held in this manner, it will often twist the rear end of the abdomen round as though to sting the captor's hand has doubtless led to the wholly erroneous idea that it can sting. No dragon-fly, let it be emphasized, stings.

Dragon-flies with Spotted Wings

THE group of stout-bodied dragon-flies comprises fewer species, but among these are some of the most interesting insects. One of them is the four-spotted dragon-fly, a fine insect with a brown body, the thorax being streaked with black along the sides. The wings of this insect are typical of the group; the hind wings are slightly larger than the fore-wings, being especially rather deeper near the body. There is a definite right angle to the inner corner of the rear wings, and both fore- and hind-wings are rather pointed. Towards the tip of each wing there is a longish brown mark, and on the fore margins on each wing there is a further brown spot. From these spots the insect gets its name. Near the base of the hind wings there is a dark patch. A near relative of this species is found in other parts of the world, where it is subject to those mysterious periodic increases such as cause swarms of locusts, which are described in Chapter 5 of Our Butterflies and Moths (page 315) The swarming dragon-flies migrate for amazing distances, their masses often darkening the sky as they pass overhead.

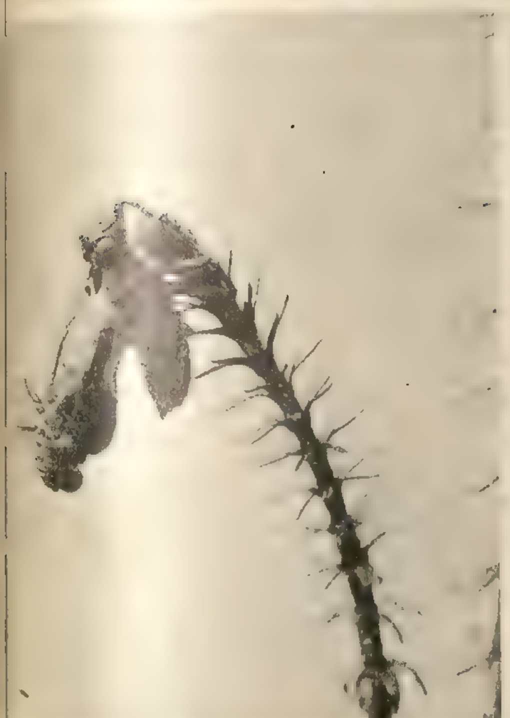
One of our finest species, the flat-bodied dragon-fly, is the species which has been specially called "horse-stinger." The body is really quite dark in colour, but in the male insect it is powdered all over with a pale violet-blue; the body of the female is brown. There is a brown patch at the base of the hind wing, and a longish bar of the same colour running outwards from the base of the fore-wing. In the males of several

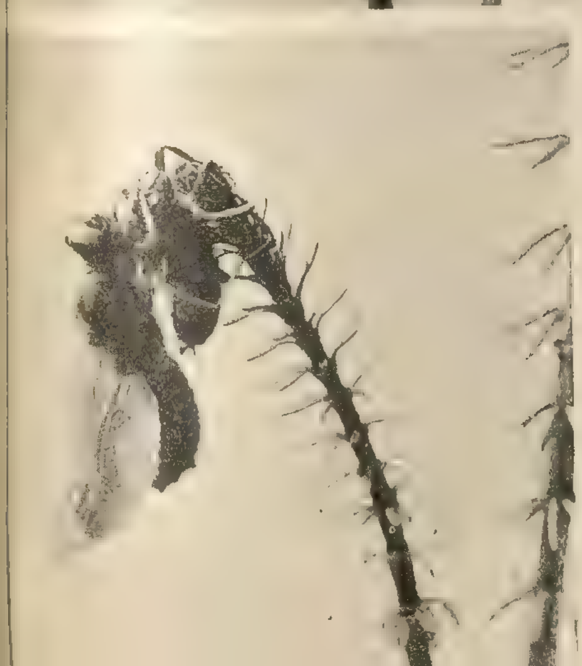
DAINTY DEMOISELLE

Its appearance accounts for this dragon-fly's name, and the bands on the wings betray its species. It is a newly emerged male of the Shining Demoiselle, a lovely insect whose brilliant blue body contrasts strongly with the brown patch on the wings. The female is less brilliantly coloured. (Slightly enlarged.)

J. J. Ward



GRUB TO DRAGON-FLY

The full-grown nymph of the flat-bodied dragon-fly, *Libellula depressa*, is a rather repulsive-looking creature, yet in the course of a few hours, passing through the stages illustrated by this photographic series, it develops into a far from unprepossessing full-grown fly. The successive stages are revealed so clearly that nothing in the nature of an explanation is required, but an advantageous comparison may be made with the series of butterfly emergences given in pages 40, 41, and 113. One difference that may be observed is the fact that the butterfly grips the stem and draws itself out of the old skin, but the dragon-fly, its legs still folded, wriggles out almost completely so that it hangs helplessly backward, as seen in the fourth photo above. Then, moving its body forward, it grips the top of the nymphal skin, draws out the rest of its long body, and is finally free. After this the wings expand and dry in a manner exactly parallel to that already seen in the case of butterflies. The pictures in this page are slightly larger than life size.

Photos, J. J. Ward

J. J. Ward

APPEARANCE BELIED

In spite of all that credulous country folk may tell the simple townsman, the dragon-flies are incapable of stinging, and this fierce-looking creature, a typical member of the genus *Aeschna*, might be handled with impunity were we to pick it off its perch.

other species we find this same characteristic of a blue-powdered body, these including the tawny dragon-fly, in which the thorax is reddish-brown and covered with stiff hairs, and the cross-barred dragon-fly, which has two black stripes along the abdomen. The powdering comes off easily if the insect should become rubbed or damaged in the net.

THE argest and handsomest of our native dragon-flies belong to the genus *Aeschna*. These are the insects which—quite justly if one judges them by their appearance—strike terror into the hearts of children, for they certainly look dangerous, with their big jaws, strong wings, and long, striped bodies. Their wings are free from markings, except for the darkening of the single cell near the tip of each wing, a feature that is found in most dragon-flies. *Aeschna cyanea* is the name of the splendid insect often seen hawking flies in the garden in summer. The body is striped with brown and blue, while a similar insect whose body and wings are entirely brown is known to the entomologist as *Aeschna grandis*.

Although the bodies of the last two spec'es are long and comparatively narrow, they are far stouter than those of the true slender-bodied dragon-flies, which comprise some of our loveliest insects. The demoiselle, as one of these is called, is a typical member of this group. All four wings are of the same shape and size, with rounded tips, narrowing gradually to meet the thorax. The head is wider in proportion to its length than in the stout-bodied group, and the eyes, instead of covering almost the whole of the fore and upper part of the head, are placed at either side of the head. The neck is extremely narrow and the whole build of the insect is much more delicate and slender.

The body of the demoiselle is a fine metallic blue-green, and the brownish wings shine with blue and purple when the light strikes them at an angle. In the female these colours are somewhat modified, for the body is metallic green and the brown of the wings is much paler. The Shining Demoiselle is a similar species, in which the wings have each a broad brown patch, while the body of the male is very dark, shining blue. Here, again, we find that the female has duller colours than the male.

B. Hanley

FOUR-SPOTTED DRAGON-FLY

A typical member of the stout-bodied group of dragon-fli[illegible] the four-spotted dragon-fly depicted above differs from the A[illegible]d shown elsewhere on this page in having a short, flat body. [illegible] wing-markings are a distinctive feature.

Finally, we come to the members of the family *Agrionidae*, which are extremely light and delicate insects. The bodies are as a rule striped with black and one other colour, such as red or blue, and the wings are amazingly fine and gauzy. Some are quite small insects, the span of the wings being not much over an inch, as compared with the four or more inches of the Aeschnas. But, despite their delicacy, these insects are just as fierce in their habits as their larger cousins.

HINTS ON INSECT COLLECTION

The field open to those who would collect insects is so vast that there are few who will have the courage, the leisure or the money to tackle the whole range of orders, and nearly all entomologists confine themselves to one or two groups. Apart from the butterflies and moths, the beetles are probably the most popular, though recently there has been much work done on the Hymenoptera, the bees, wasps and ants. In this order especially, however, most of the collectors have been real specialists, devoting their time to one family, or even, in some cases, to a single genus. Such confined interests need great enthusiasm and a wide knowledge, not only of entomology, but of biology in general.

Few beginners, of course, will wish to limit their activities in this way, and, in fact, it is never a bad plan to start with a general collection, for, sooner or later, one becomes interested in a single group, and then specialization can begin. There is, fortunately, no necessity to devote one's attention solely to any one group, and there are many avenues of approach to the whole subject of insect collecting which are relatively unexplored. For instance, the collector who has a fair general knowledge might do well to devote some time, not to any one group, but to one definite association of insects. By the term "association" we mean those insects that are all found in more or less the same habitat, such as the oak, pine or beech wood, or the water-meadows, or the chalk downs. Such specialization as this, however, will soon be found to entail a far larger collection than was originally expected, and then a narrower boundary will have to be set. The insects of the oak-tree form an obvious group that one might feel capable of tackling, but even here there is so wide a field that, after a year or two, the problem seems as big as that of the general collection did some time earlier. However, some such idea as this may be welcome to the collector who desires rather to learn all he can about a few insects than to amass innumerable specimens of creatures whose ways he will never have time to discover.

CHEERFUL SONGSTERS IN EVERYBODY'S GARDEN

CONTINUING our portrait gallery of British birds, we see in the pages that follow the features of two homely songsters that enliven with their cheerful notes our fields and gardens, lanes and woods. The first of the pair is the chaffinch, and its companion in this detailed survey is the hedge accentor—or hedge sparrow, as it is more commonly styled, although it has no connexion with the true sparrow

PERHAPS because it is one of the commonest of our birds the chaffinch is seldom regarded as one of the handsomest, although it certainly merits this description. We must see the cock chaffinch at close quarters to appreciate to the full the fineness of his feathers. The underparts range from a warm, brownish-pink on the cheeks to deep pinkish-red on the breast, and then fade to white beneath the tail, while there is a slightly paler band round the chin. The head has a slight crest and is bright slate-blue, this colour contrasting well with the chestnut-brown of the back. The rump is greenish, and the greenish-brown wings are crossed by a stripe of yellowish-white, while there is a brilliant white patch on the shoulder. The outer tail-feathers are edged with white. In the female this last feature and the presence of the white shoulder-patch form the only bright points of the plumage. Her general colour is greenish-brown above and paler brown beneath, and she is completely outshone by her brilliant mate, who cuts a very dashing figure in his spring plumage and throughout the mating season. In winter, and, in fact, soon after the close of the breeding season, the plumage of the male, too, becomes dirtied and also obscured by the tips of the wing feathers turning brown or grey so that the real colour is hidden.

A. R. Thompson

NEAT DESIGN

The chaffinch's nest is regarded as among the neatest built by any of our birds—some would go so far as to say that it has no rival in this respect. Lichens ornament the nest's exterior and sometimes, as in this example, help to disguise it when looked at from below. The eggs lie snug and secure in the nest's deep cup.

The chaffinch has all the typical features which are noted in page 320 as being characteristic of the finches, namely, the short, conical bill, sturdy build, finely coloured plumage, and good song. The male birds are remarkable for the fact that in winter they very often live a more or less solitary life, neither consorting with the little flocks of females, nor mixing with the larger companies of other finches and buntings which haunt the fields and rickyards during the cold season. It was this fact, coupled with an idea that the two sexes

ON THE THRESHOLD

The parent chaffinch, its beak full of good things for the tiny nestlings, perches on the edge of what is beyond cavil a fine example of avian craftsmanship. Though often exposed, the nest of the chaffinch may occasionally be found placed in a deep bush or hedgerow.

O. G. Pike

migrated separately, which led Linnaeus to give to the chaffinch the specific name of *caelebs*, the Latin word for bachelor, and an old popular name for the bird was bachelor bird, or bachelor finch. Much evidence, however, has been brought forward in recent years to show that this is a rather mistaken idea, but the fact remains that whereas the females seem always to flock in winter, we certainly see a fair proportion of solitary males after the breeding season is over. Large flocks of both sexes, however, may be found in beech woods in winter, where they consort especially with bramblings, which are among the winter visitors.

Fine Craftsmanship of the Chaffinch

ESSENTIALLY a bird of the hedges and of country where trees abound, the chaffinch is also common in the garden, and its nest is almost as familiar as those of the blackbird and the thrush. One of the most beautiful examples of the nest-building art produced by any bird in this country, it may be described as resembling the lower portion of a rather large, long-tailed tit's nest that has been cut in half. Lodged usually in the crook of a branch, often in an old apple or pear tree, it is made of moss, hair, wool and other soft materials with an outer layer most frequently composed of lichens, and is put together in such a way as to be very difficult to detect in a grey, lichen-covered old tree. The lining consists of hair, feathers and the down from plant seeds, such as those of the sallow. As we so often find, the male does very little of the work of constructing this lovely home. The eggs number from four to six, and are whitish-brown with uneven purplish spots; sometimes they are entirely brown with blackish markings. The song of the male is a loud, pleasant, incessant and cheerful rattle, which begins and ends with equal abruptness. Between snatches of song the bird gives a low, rough, but rather soothing *krrr*, a sort of sigh of pleasure. The call note is an unmistakable *pink, pink*, a sound which in many parts of the country has earned the bird the name of "spink."

OF DISTINCTIVE SHAPE

A neat, well-hidden nest of grasses and moss contains the sky-blue eggs of the hedge accentor, or hedge sparrow, as many would have it. The shape of the eggs is as distinctive as their colour, for they are rounded, and then suddenly come to a point at o...

Like the other members of the finch tribe, the chaffinch is a great seed-eater, but it is more insectivorous than most of its relatives. During the winter the birds consort with other finches and buntings, and flocks are often to be seen in the fields and about the rickyard, which is a paradise for seed-eating birds at that time of year. The chaffinch displays unusual skill in hawking after flies and other insects, and when caterpillars and aphides swarm on the trees in summer, it will vie with the flycatchers themselves in picking off choice morsels as it hovers above the leaves.

LUCKY SOMEONE!

There is an almost sentimental look in the eye of this cock chaffinch, and certainly his family are lively youngsters of whom any father might be proud. This picture shows the parent's own fine plumage, with blue head, red cheeks and brilliant wing-bars.

F. Vear

R. Chislett

QUIETNESS PERSONIFIED

One may call the hedge sparrow (no relation to the house sparrow) a quiet bird, for greys and browns compose his colour scheme, and the sombre depths of the hedgerows are his home. Nevertheless the hedge sparrow can compare, aesthetically, with the brighter-hued cock chaffinch seen opposite.

The second of the birds to be described in the present chapter, the hedge accentor, though equally common, is perhaps the most retiring and the plainest of all our birds. It is more usually called the hedge sparrow, though the latter part of this name seems to be due more to its commonness than to any resemblance that it bears to the house sparrow.

Some Facts About the Hedge Sparrow

Several common features connect the hedge accentor with the chaffinch in the mind of the bird-lover. Both are birds of the garden, both are extremely common, and, finally, both have a pleasant and insistent song. It is, in fact, only by its song that the accentor's presence is betrayed, for it is a bird which we seldom notice even when it comes out into the open. The upper parts are brown, with blackish streaks, and the head and underparts are a warm slate-grey, a colour which is less conspicuous than one might expect. The young birds are without the grey head and are browner and rather spotted below.

The nest of the hedge accentor is built of roots or twigs as a basis, with moss and grass to form the walls and a lining of hair and wool, the whole effect being pleasantly trim and neat. It is placed in a hedge, bramble bush, thicket, faggot-stack, or among the thick ivy round the base of a tree. The eggs are a very beautiful, brilliant, slightly greenish-blue, clear and devoid of markings of any sort. The reason for the coloration is rather hard to understand, for other birds that have eggs of a somewhat similar colour, such as the redstart and the wheatear, nest in holes. Although such eggs as the accentor's must be very obvious to any enemy passing overhead, this fact cannot account for the frequent robbing of the nests, which is usually the work of rats and mice, creatures that would have to climb before they could see into the nest. Four or five is the usual number of eggs in a clutch. A further point with regard to the accentor and its nest is that this bird, in the south of England at any rate, is the victim most frequently chosen by the cuckoo for her nefarious work. In the north, where the accentor is not so common, the nests of pipits, wagtails and robins are more usually selected.

Although the song of the accentor is one of the most familiar sounds of the countryside, it is a curious fact that one may live for years in the country without ever

U. W. Teager

ON THE LOOK-OUT

The hedge sparrow does not often perch in the manner seen in this photograph, for this active little bird is more fond of the thicket than of the open. From the look in her eye, this hen bird seems to be expecting something, and we may hazard a guess that she is awaiting the notes of her spouse's song.

noticing it; and then, having learnt to recognize it, perhaps by accident, one finds that there seems scarcely any time of the year when it cannot be heard. It consists of a rather high-pitched and not unmusical repetition of some half-dozen notes, not loud, but vigorous and oft-repeated. In the winter months the accentor's song is often a quiet little intimate twittering rather than a song in the general sense of the word. One may quite frequently hear the song at night, and the bird will sing if suddenly disturbed by a noise or light. The call note is a shrill piping, which may be rendered as *peep*, and this is uttered continuously as the birds hop about among the leaves and refuse at the base of the hedges and banks where they are in the habit of seeking their food.

A notable point about the accentor is that it seems unwilling to take to the wing in situations where other birds would have recourse to flight. When the chaffinches and other birds are swarming around insect-infested trees, the accentor will hop about on the ground, industriously picking up caterpillars and grubs that have fallen, rather than hawk round the branches and take the insects off the leaves. Again, when the accentor hops, it does not move with the usual motion of a hopping bird, but in a rather jerkier manner, with the body held low, parallel with the ground, and not in an upright position.

Insects, and other small invertebrates, and the seeds of weeds form the major part of the accentor's diet, and, as has already been indicated, it is almost entirely a ground feeder. Often we may see the bird in the cabbage patch, apparently hiding under the big, low leaves of the plants, but actually taking advantage of the fact that the undersides of the leaves are more productive of food than the upper, more exposed surfaces.

A popular country name of the accentor, and one that is especially widely used in the north of England, is dunnock, which is modified in some places to blue dunnock, in reference to the colour either of the head or of the eggs. If this name, and that of accentor, were more widely used, this little bird might perhaps receive a fairer share of attention, and at least it would be relieved of the stigma that attaches to the word sparrow, which inevitably connects it with the house sparrow. To call it "sparrow," in fact, is libel!

HINTS ON BIRD WATCHING. 5

In our last practical note (page 210) we gave some interesting data concerning the distances flown by birds during the course of their everyday lives, and it was remarked in this connexion that only by extremely long and patient watching can facts of this nature be gleaned. How few and far between are the people who consider it worth while to watch birds in this manner can be realized when we come to examine, impartially and critically, the extent of our knowledge about some of our commonest birds.

The blackbird and the thrush, for instance, two of our most popular avian friends, would seem to have been the subject of no really intensive research. What really happens in the average day of the life of, say, a nesting hen blackbird, whether she is building the nest, sitting on her eggs, or feeding her growing brood? When does she start work? How many times a day does she stop to rest? How much does she eat? When does she retire for the night? All these are questions on which we appear to have no really good information. In fact, if even some of our finest bird-watchers and photographers were asked to give a concise account of the daily life of the blackbird, their answers, stripped of all unnecessary phrases, would come to little more than can be found in the average popular ornithological text-book. It is not intended to deprecate in the slightest the work of our bird-photographers and watchers, but it is a fact that they have worked chiefly on the rarer and more inaccessible species, still leaving us in the dark as to the domestic life of the birds that we see in our gardens and parks.

It is here that the beginner has his chance. Provided that he is capable of making good notes, of distinguishing between what he thinks he sees and what he really sees, of sitting for hours, it may be whole days at a time, in a rather cramped position and keeping his eyes and ears wide open all the time—then he may himself fill the deficiency. In the very fact that he cannot get to the Scottish islands or the Norfolk Broads, the haunts of the expert, lies his strength: forced to work in his own garden, he may do there more valuable work than the best-equipped photographer in the most remote sanctuary.

THE CLASSIFICATION OF CLOUD FORMS

To the casual observer, the clouds as they pass across the sky may seem extremely refractory subjects for classification. Their shapes are so diverse and so swift-changing that, while the characteristics of one form are being noted and catalogued, a new form drifts into view and disperses the other into space. Yet the apparently unclassifiable can, and have been, classified, as the following chapter shows

WHETHER we live in narrow streets or in the open of the country, even the most unobservant amongst us cannot fail to be attracted at times by the passing pageant of the clouds. Now rotund and full-bodied, sailing across the sky like galleons on an azure sea; now fleecy as a woollen pile or spread in a horizontal sheet—now black with the menace of storm, now bright with the promise of a fine tomorrow—they present a fascinating spectacle, one full-charged with beauty, and, to the informed, pregnant with meaning.

Long before history began men watched the sky with anxious and inquiring eyes, for then, far more than in these days, human activities were affected by the vagaries of the weather. Even today, however, most people like to know what sort of weather is likely to prevail tomorrow or the day after, and the state of the clouds, to a greater degree than any other meteorological phenomenon, constitutes a basis for reliable weather prediction.

The first step in scientific progress is an ordered classification. There was abundant speculation about clouds and their meaning for many, many centuries before a systematic classification of the various forms was attempted. Perhaps men were chary of making the attempt, so chaotic seemed the multitudinous shapes assumed by the nebulous voyagers across the sky. Whatever the reason, it was only in 1802 that a system of cloud classification and a generally-acceptable nomenclature were devised. The honour of having taken this great step forward lies at the door of the eminent British meteorologist and chemist, Luke Howard (1772-1864), whose original definitions of the chief cloud forms are still in use today.

There are now several types of classification, all founded on different scientific theories as to cloud origin, but the majority are of more academic interest than practical value. It is obviously necessary, for the purposes of modern weather forecasting, that one system of classification should be used throughout the world, and that one type of cloud should be given the same designation in every language. To achieve these desirable objects, an International Meteorological Committee met at Upsala in 1894, and several sub-committees were appointed to report on the various classifications then in use and to devise a universal system. The result was the present international system of cloud nomenclature, which is now used throughout the world by all meteorological institutions. Further, the Committee published in the principal European languages an "International Cloud Atlas," which

ICY CIRRUS

Cirrus (Ci.) clouds occur only at very high altitudes (20,000-40,000 feet) and are composed for the most part, not of minute droplets of moisture, but of ice crystals which give to the clouds a distinctly silky appearance. The photograph below illustrates general cirrus characteristics, but the variety of forms encountered is very great

G. A. Clark

DOMED CUMULUS

Cumulus (Cu.) clouds (2,000-5,000 feet) are flat-based and dome-topped. When occurring as on the horizon in the photograph below, with a ragged outline, they are known as fracto-cumulus (Frcu.) and may often be a sign of fair weather.

G. A. Clark

is now in general use wherever there are scientific observers of clouds and wherever meteorological reporting stations are in being. A new and revised edition of the "Atlas" was published in 1930.

The whole basis of the classification is that clouds take up a limited number of forms according to the height at which they occur. The commonest of these forms is the heaped-up, woolly-looking cloud which is apt to appear on a spring day, and which is so widely used by artists in the painting of landscapes. The top of this cloud appears to be humped in a series of rounded masses of vapour, while the bottom is usually a more or less horizontal line. By reason of the cloud's thickness, the sunlight playing on the surface gives very beautiful effects, and a number of such clouds spanning the sky on a spring day forms one of the loveliest of Nature's scenes. This type of cloud is known in meteorological language as *cumulus* (Lat., heap).

G. A. Clark

TANGLED CIRRO-STRATUS

The streaked, whitish veil of clouds shown in the above picture is composed of cirrus clouds (20,000-40,000 feet) arranged ... layer, the cloud system as a whole being known as cirro-strat... (Cist.). Being composed of ice crystals, this formation does not blur the outline of the sun or moon, but gives rise to ...

Clouds the Artists Favour

As a contrast to the cumulus formation there are those clouds which arrange themselves in enormous horizontal sheets or layers, whose vertical height is small compared with their great extension in a horizontal direction. These clouds are often seen on the far horizon on a summer evening and are favourites with artists painting sunsets, mainly because of the black line which they make across the brightness of the remainder of the sky. To these the name *stratus* (Lat., spread or stretched out) is given.

The third of the most important cloud formations has a light and airy appearance and occurs only at very high altitudes. It is apt to be so thin that the blue of the sky may be seen shining through at regular intervals, and in a high wind this formation will often give the impression that a number of enormous feathers have been stretched across the sky. On a very warm summer day these clouds will mask the sun sufficiently to protect us from its red rays, but not enough to absorb the ultra-violet rays which produce sunburn. Thus in summer we may be very sunburnt at the end of a country ramble although there has been no real sunshine throughout the entire day. These high-altitude clouds are known as *cirrus* (Lat., curl).

SHAPELESS NIMBO-STRATUS

These nimbo-stratus (Nbst.) clouds (500-2,000 feet) mean that much rain is in store, unless the direction of the wind indicates that the storm has just passed over. Described as a low, amorphous and rainy layer of dark grey cloud, the nimbo-stratus formation invariably brings with it continuous rain or snow.

G. A. Clark

Clouds are formed at all altitudes. At times they occur just above the surface of the ground, and are then known as "fogs." When climbing a mountain there is always some possibility of being enveloped in a passing cloud; sometimes the cold ground of the mountain projecting up into a perfectly clear sky of warm air, containing a great deal of moisture, results in the formation of a halo of cloud round the top of the mountain which may remain for days on end.

Besides lying near the ground, clouds also attain tremendous heights, and even with the aid of modern instruments it is difficult to estimate in exact figures the extent of their elevation. At some meteorological stations pilot balloons are used to determine cloud height; as the balloon rises at a known rate, it is only necessary to note the time that elapses between its release and its disappearance in the clouds to make the calculation. In mountainous districts the height of clouds lower than the tops of the visible hills may be judged by inspection if the latter's height is known.

The average height of an *upper layer* of cloud in Britain may be taken as about 30,000 feet,

G. A. Clark

FLEECY ALTO-CUMULUS

This broken layer of alto-cumulus (Acu.) clouds belongs to the intermediate group of formations, and occurs anywhere between 6,500 and 20,000 feet. The patches of cloud may sometimes be widely separated, and often have a turreted structure indicating great vertical development.

while *intermediate layers* appear at from about 6,500 to 20,000 feet. The *lower layers* occur usually at between 500 and 5,000 feet. The international nomenclature has been so arranged that, besides describing the form of a cloud (*cirrus, cumulus* and *stratus*), it is also possible to give some indication of its height. Since cirrus clouds are usually very high, the prefix *cirro* is used to denote those in the uppermost layers (30,000 feet). The word *alto* in front of the name of a cloud formation means that it occurs in the intermediate layers, while in the lowest layers a prefix is rarely used.

Broadly, we may say that clouds at over 20,000 feet are usually either *cirrus, cirro-cumulus* or *cirro-stratus*; that those in the intermediate layers, about 15,000 feet, may be either *alto-cumulus* or *alto-stratus*; and that the lower clouds at below 6,000 feet are *stratus, cumulus*, or, if depositing rain, *nimbus* (Lat., rain-cloud).

As given in the "International Cloud Atlas" the modern classification consists of ten main types. The first, *cirrus*, is defined as "detached clouds of delicate appearance, fibrous structure, without true shadows, generally white in colour. Cirrus clouds take the most varied shapes, such as isolated tufts, thin filaments pencilled on a blue sky, branched filaments in feathery form, curved filaments ending in tufts, etc. Often they are arranged in bands which traverse part of the sky as arcs of great circles and which by perspective effect converge towards two opposite points on the horizon." Then come: 2, *cirro-cumulus*, "small rounded masses or white flakes without shadows, arranged in groups or lines, or sometimes in the form of ripples such as those formed on the sea-shore;" 3, *cirro-stratus*, "thin veil of whitish cloud, sometimes entirely diffuse and giving the sky a milky appearance, sometimes showing more or less distinctly a fibrous structure"; 4, *alto-cumulus*, "rounded masses or discs, more or less large, arranged in groups, in lines or in rows, following one or two directions and sometimes so crowded together that their edges are joined"; 5, *alto-stratus*, "a veil of a colour more or less grey: sometimes the veil is translucid resembling a thick layer of cirro-stratus and through it the sun or moon can be seen dimly gleaming as through ground glass"; 6, *strato-cumulus*, "large, lumpy masses or rolls of dull, grey cloud frequently covering the whole sky and sometimes giving it an undulating appearance"; 7, *stratus*, "a uniform layer of cloud, like fog in appearance but not lying on the ground"; 8, *nimbo-stratus*, "a low layer of structureless and rainy-looking cloud, sombre grey in colour." Next we have 9, *cumulus*, defined as "thick cloud whose summit is dome-shaped and exhibits protuberances, while the base is nearly horizontal: when the cloud and the sun are on opposite sides of the observer, the surfaces facing the observer are more brilliant than the margins of the protuberances." When, on the contrary, it is on the same side of the observer as the sun it appears dark with bright edges. When the light falls sideways, as is usually the case, cumulus clouds show deep shadows. True cumulus has well-defined upper and lower margins, but there are sometimes to be seen ragged clouds—like cumulus torn by strong wind—of which the detached portions are continually changing in shape: to this form the name *fracto-cumulus* is given. Finally, there is 10, *cumulo-nimbus*, "great masses of cloud rising in the form of mountainous towers of which the upper parts, of fibrous texture, sometimes spread out in the form of an anvil."

SOMBRE STRATO-CUMULUS

These strato-cumulus (Stcu.) clouds form a thick layer at a low level of about 1,500 to 4,500 feet. The height of the layer is uniform throughout, while the heavy shadows between the semi-detached patches of cloud are typical of the formation.

G. A. Clark

GOLDEN BUTTERCUPS OF THE SUMMER MEADOWS

WHAT is the most charming feature of Britain's country scene in summertime? The question posed, some would reply one thing and some another, but we may be sure that high in the esteem of all would be the masses of golden flowers starring the lush meadows —the flowers we know popularly as just buttercups. As will be seen from what follows, there are several varieties of this favourite flower

AMONGST the best-known and most decorative of our wild flowers, the buttercups are essentially plants of the meadowland and the woods. On moor and mountain we need not expect to find them, nor are we likely to see their golden blooms along the seashore or among the sand dunes, but almost every one of our native species is to be found within easy reach of town or village, often at our very doors.

The plants known by the popular name of "buttercup" are all members of the same genus. They are sometimes called crowfoot, a name which is also applied to other members of the same genus that are never called buttercups. The genus itself is known to botanists as *Ranunculus*—this Latin word is the diminutive of *rana*, frog—since its members prefer damp situations, and it gives its name to the natural order *Ranunculaceae*, which order has pride of place in botanical classification, being the first to be dealt with in all systematic floras and books about plants.

BUTTERCUP 'BULBS'

It is easy to see from this photograph why the bulbous buttercup was given its name. The bulb-like organs seen at the root are not true bulbs, however, for in structure they are rather different from the bulbs of the daffodil and other plants. They are formed, in fact, from the swollen bases of the leaves.

H. Bastin

The members of this order have simple, regular flowers which show all the typical features that were noted in the first chapter of this series (page 9). The noteworthy features are the presence of five sepals; five petals, which may be irregular in shape; a large number of stamens; and, generally, a fair number of ovaries. The fruit in plants of this order is usually of the form known as a carpel; this term, from the Greek *carpos*, fruit, is used to describe each single cell of an ovary. In the *Ranunculaceae* the carpels contain any number of seeds, from one upwards. They are usually hooked at the top, so that they catch into such objects as the wool of sheep; by this simple means distribution is ensured. Three of the members of the genus *Ranunculus*, the lesser celandine and the greater and lesser spearworts, have already been described—the first in page 161, and the other two in page 254. Of the others, several are extremely common, and these comprise what are commonly called buttercups, namely, the creeping, the bulbous and the upright buttercups. Each of these names is sufficiently descriptive of the main features of the plant, and the following accounts should suffice to make final identification a simple matter.

Features of the Creeping Buttercup

THE first of the above species, the creeping buttercup, is one of the commonest and most tenacious of all weeds. It is distinguished from its near relatives by the fact that the rootstock is thick and strong, and sends out innumerable spreading runners, which cover the ground with a network over an area of many yards. The flowering stem, which is furrowed, runs slanting upwards for from one to two feet, and the flowers, which have the typical features of the genus, appear about May and last until August. The petals are rather spreading, so that the flower is more saucer- than cup-shaped. The leaves, which in the buttercups are frequently of two types, grow either radically or up the stems at the bases of the flower stalks. The radical leaves are palmate, consisting of three deeply-cut lobes, each of which is subdivided, the terminal one having usually the same form as the whole leaf. The flower stalks arise from the points at which the suckers send their roots down into the soil, so that, if all the other plants could be cleared away, the network created by a single plant of the creeping buttercup would appear as a series of individuals connected to each other by a number of straight, green runners.

H. Bastin

CHILDREN'S FAVOURITE

The buttercup that the children love so much, the meadow buttercup, is the largest and finest of our common species, covering the fields with its golden blooms. The finely-divided leaves and wide-spreading flowers are easily seen in this picture, and also the upright, thin stems, which are among the features that distinguish the meadow from the other buttercup species.

Perhaps the bulbous buttercup is best-known as a weed that has a peculiar fondness for lawns, where it finds the firm, well-rolled turf very suitable to its mode of life. As is indicated by the name, the chief feature of the plant is a bulbous rootstock. This is made by the swelling of the bases of the leaves, as we can see by digging up the plant, when each radical leaf is found to terminate in a flattened white sheath, which covers part of the so-called bulb. On our lawns this plant, if it is allowed to flower at all, has only a short, stiff flower stalk, but in the lush meadows, where it grows to its greatest extent, its yellow flowers appear at the top of a stem that may be anything up to two feet in height. The flowers are easily distinguished by the fact that the sepals are turned downwards and backwards in such a way as almost to touch the stem below the flower. The leaves are of the same type as those of the last plant.

THE third of the common species of buttercup is the largest, and is the plant that is the favourite with country children. The upright, common, or meadow buttercup, as it is variously called, sends its straight, strong stems upwards for as much as three feet, as, indeed, it must if it is to compete successfully with the other plants of the meadows during the height of summer. The root system consists of a more or less simple, erect root, which thus serves to distinguish it from the two species already described in this chapter.

OTHER distinctive features of this plant are the stems, which are simple and not furrowed; the way in which the flowers expand so as to be almost completely flat; and the leaves, the upper ones of which are divided into a number of slender segments. The upright buttercup comes into flower rather later than the others, being at its best in July. Its specific name, *acris* (Latin for bitter), refers to the bitter juices of the whole plant; for this reason it is avoided by cattle, as also, though in a lesser degree, are almost all the members of the order.

Of the many other species of the same genus, one at least is often known as a buttercup. This is the celery-leaved crowfoot, a plant which is remarkable in being found in practically the same form in every part of the world. In England it is widely distributed, and it is rather fonder of

COSMOPOLITAN CROWFOOT

The flower seen in the photograph below, in appearance very unlike the typical "buttercup," is the celery-leaved crowfoot, a near relative of the buttercups shown in the other illustration in this page. Found almost unchanged in every part of the world, it is easily distinguished by its leaves and its curious fruits of oblong shape. (A little more than life-size.)

A. W. Dennis

H Bastin

BUTTERCUP COUSINS

The wood crowfoot, or goldilocks, the hairy buttercup, and the corn crowfoot, shown above (reading from left to right), are not so hard to distinguish as might seem at first glance. A close examination of the photographs will show features—leaves, flowers, and stems—that should enable the amateur naturalist to pick out each species with ease "in the field."

damp places than any of the species already mentioned. Its distinguishing features are the pale yellow flowers, which are slightly less than a quarter of an inch across, having the sepals hairy and reflexed as in the bulbous buttercup illustrated in page 336. The fruits are borne in oblong heads, and the stems, which are hollow, contain extremely acrid juices.

THE name buttercup is often applied to another species which is also known as the pale hairy crowfoot. The flowers, nearly an inch in diameter, are similar to those of the typical buttercup, and they also exhibit the feature of the reflexed sepals. The stem is noticeably hairy, and grows upright to a height of only a foot. The whole plant, moreover, has a stunted appearance, which enables it to be distinguished fairly easily from any of the other species. It is found commonly from June onwards in meadows and pastures.

Wood crowfoot is a fine species, better known by its more picturesque name, goldilocks. Flowering as early as April, and found generally in woods, it is readily distinguished from the other species, not only by its situation and the time of flowering, but also by the leaves, which are smooth and less deeply lobed than in most species; those that grow up the stems are sessile, each leaf being divided into a whorl of about eight simple lobes. The flowers are very irregular, one or more of the petals being often undeveloped.

FARMER'S FOE

One of the worst weeds that the farmer may be called upon to fight is the creeping buttercup, which spreads, by means of the runners well shown in this picture, over a considerable area. Not even the lovely gold of its blooms will appease the farmer whose meadows are turned by its growth into a children's flower-garden!

H. Bastin

Crowfoot Weeds on the Farm

FINALLY, we have two species which are most often found growing on cultivated land, especially land that has suffered from bad farming. These are the corn crowfoot and the small-flowered crowfoot. The corn crowfoot has pale yellow flowers about half-an-inch across, and pale green, smooth, shiny leaves, which are very deeply cut up into a large number of narrow segments. The flowering stems, which are hairy, and solitary, are as much as two feet in height, thus being enabled to compete with the flourishing stems of the corn among which they are usually found growing.

The small-flowered crowfoot is less widely distributed than the other species, though it is probable that its alleged scarcity may be accounted for by its insignificance. It does not occur in Scotland. The flowers are $\frac{1}{4}$ inch in diameter, rich yellow in colour, and have the sepals bent down in the same manner as we have already noted in several other species. A further feature of interest is that they grow opposite the leaves instead of from their axils. The slender stems are prostrate and the whole growth of the plant is very low—almost creeping, in fact.

Besides the species described, we have in England several white-flowered species, such as water crowfoot and ivy-leaved crowfoot, both of which are subdivided into various sub-species; they are described in a later chapter, since their habitat is different from that of the buttercups.

BUTTERCUP MEADOW

Britain's countryside can show no more lovely sight in summer-time than a meadow or stream-bank covered with a brilliant carpet of golden buttercups. To the uninitiated all buttercups look very much alike, but in reality there are several species

H. Bastin

CALLOW CLAMOURERS

Some of the most charming examples of the photographer's craft have for their subject chicks clamouring to be fed. Here we have two cases in point, the upper photograph being of hedge sparrows, and the lower of chaffinches. Both birds are described in the chapter "Cheerful Songsters in Everybody's Garden," in pages 329 to 332

F. Jefferson

RABBITS YOUNG AND OLD

Delightful little creatures are the " bunnies " seen on a summer evening scampering about the mounds that mark their warrens. The photographer has succeeded in approaching them more nearly than the rambler may expect to do, and above we see a litter of young rabbits in the nest, and below two unsuspecting adults breathing the evening air

F. Jefferson, J. H. Vickers

WHITE POPLAR
Most poplars are handsome trees, and the white poplar in particular often grows to an imposing size. Here a fine specimen is seen standing in park-like surroundings and displaying all the glory of its summer foliage

SWAYING POPLARS IN GARB OF RIPPLING GREEN

THERE are several species of poplar, and in the chapter below we make the acquaintance of three of the best-known—the white poplar, the aspen, and the grey poplar. The Lombardy and black species are dealt with in a later chapter. Although, botanically speaking, they are so closely akin, the poplars reveal striking differences, which will be apparent from a study of the pages that follow

OF the five species of poplar found more or less commonly in the British Isles, only two, the white poplar and the aspen, are generally considered to be native, for the grey poplar, though probably indigenous, is thought by many to be only a cross between these two, or at most a sub-species of the white poplar. The white poplar is the finest of any of the poplar species found in this country. It owes its name to the colour of the leaves, which are covered below with thick, mealy, white down ; when, however, they have fallen and lie rotting on the ground they turn black.

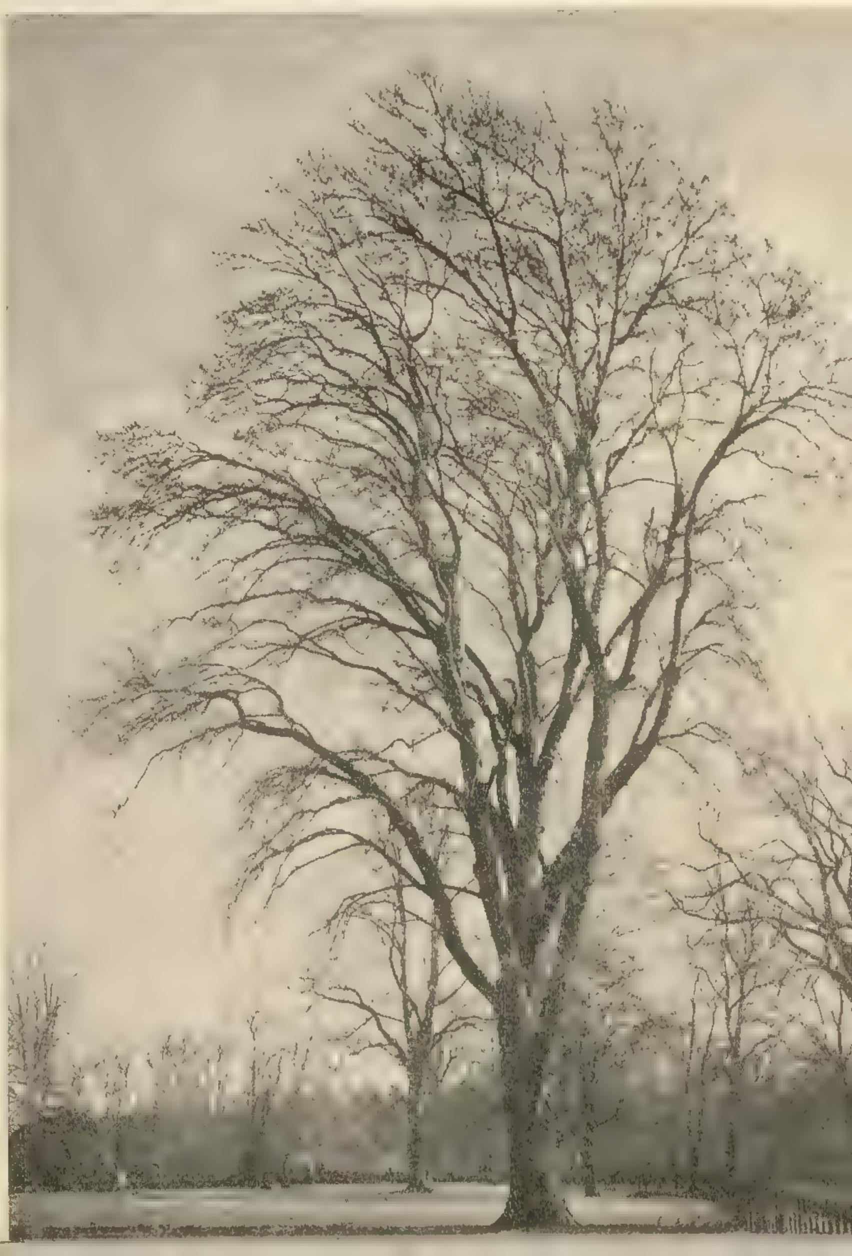
All the poplars, in common with their near relatives, the willows, have the flowers of different sexes borne on different trees, so that they are of the type known to botanists as *dioecious*. The pollen is distributed by the wind, and the flowers are borne in catkins. These are features which have already been noticed under the sallow (*see* page 123). The poplars differ from the willows, however, in their catkins, which hang downwards and are often four inches or more in length, whereas the willow catkins are short and usually erect. These flowers are also remarkable for the fact that the perianth is entirely absent, the stamens being protected by a small scale. In the white poplar there are from four to twelve of these stamens in the male flowers. The male catkins themselves are often as long as four inches, and the purple anthers at the tips of the stamens make them very conspicuous, especially when they fall to the ground in masses during March and April, looking more like huge, hairy caterpillars than like any part of a tree. The female catkins are much shorter, having two yellow stigmas, each of which is slit at its tip. The seeds, which are contained in egg-shaped capsules, have each a long, silky filament attached. When they ripen and fall from the capsules, towards the end of July, the ground is covered with the conspicuous long threads, which serve as parachutes in the distribution of the seeds.

ACTUALLY, there is little need for the white poplar to rely on seed for its propagation, since its roots send up great numbers of suckers, which themselves develop into trees all around the original parent. The leaves, which in the main tree are very broad, with darkish, shining green upper surfaces and are of the shape known as cordate, are very much larger and rather more triangular in outline on these suckers. The presence of these suckers and the size of their leaves is evidence of the tree's vitality.

In stature the white poplar often reaches a hundred feet, and the girth may be twelve feet in an average specimen. The bark on the bole is rough and dark, divided by many longitudinal splits, but higher up it is whitish and rather smooth, broken only by marks running round the trunk in much the same way as is seen in the birch. In some cases, these marks are of curious diamond shape, as in the bole shown in page 346. The branches off-shoot at a rather acute angle,

SHAPED BY THE WIND

For all this white poplar's impressive height and apparent strength, its branches nearly all bend to the left—eloquent evidence of the direction of the prevailing wind and of its long-continued and practically irresistible force

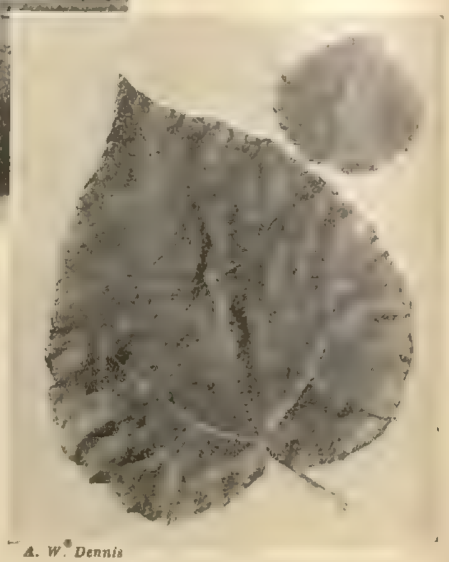


owe their chief beauty, namely, the fascinating way in which they quiver and tremble in the slightest breeze. This is due to the fact that the leaf-stalks are flattened in a plane at right angles to that of the leaves, so that when they are moved by the wind the leaves tend to flutter sideways instead of up and down.

Smaller and altogether more delicate than the other poplars, the aspen is a tree that often escapes notice, for it is more often seen as an ornamental garden tree than in the wild state. It grows well, however, on light soils, and is a hardy tree, flourishing at over 4,000 feet above sea-level on the Continent. Where it is found wild it is one of our most delightful trees, a fascinating feature being the continuous shivering of the leaves. Often they quiver and move when the air seems perfectly still. As we look up through the branches we see first one leaf begin to move,

WINTER SORROW

It cannot be denied that there is some suggestion of mournfulness in the characteristic droop of the aspen's delicate branches. In this photograph of a clump of aspens beside a stream—aspens love a moist soil—we may note the dark patches in the boughs where catkins are beginning to appear.



A. W. Dennis

ASPEN LEAVES

The aspen suckers have enormous leaves, many times the size of those of the tree itself. Here the two are seen on the same scale—about half actual size.

so that the form of the tree is often almost diamond-shaped in outline.

Poplar wood is not of verv great value to the timber merchant, but it has certain qualities which make it useful in special circumstances. It is light, both in weight and colour, and rather soft, but owing to the very quick growth of the tree it is not at all durable. Its chief use is in the manufacture of boxes, where its lightness is an advantage, and of hospital splints, where its combination of lightness and non-liability to splinter is of great importance. It will not burn easily, and, largely for this reason, is used in making floors.

The leaves of the poplar show a feature which is peculiar to these trees, and is the one to which they

then another, then more, until the whole tree is rustling and shivering, while all around there is apparent stillness. This quivering, which is found even more in this tree than in the other poplars, is due to the vertically flattened leaf-stalks being very much longer than in most species. From this feature comes the oft-used simile, "trembling like an aspen leaf."

SUMMER RADIANCE

In striking contrast to the rather sorrowful beauty of the aspen in winter—well-evidenced in the photograph in the opposite page—is the dainty mass of foliage that scintillates joyously in the brilliant sun of a summer's day. Even in summer, though, the droop of the boughs is still pronounced.

Aspen leaves are broader than those of the white poplar, and are often almost round in outline, with their edges toothed and waved. There is a variety of the tree in which the undersides of the leaves are covered with hairs, but in the typical form they are quite smooth. Like the white poplar, the aspen sends up numbers of suckers from the spreading roots, which are close to the surface of the soil. The leaves of the suckers are larger than those of the tree proper; they have smooth margins and are also less circular. Cattle are especially fond of browsing on the suckers' leaves.

The catkins of the aspen are shorter than those of the other poplars, being from two to three inches in length, and they are further distinguished by the fact that the scales guarding the flowers are jagged, instead of smooth-edged as in the white poplar. The timber is rather poor, and the tree, which may grow to as great a height as eighty feet, is mature at the age of only about 50 years, after which it often decays very rapidly. The wood is one of the favourite haunts of the larvae of certain wood-boring moths and beetles, and the trees are therefore one of the happiest hunting grounds of the entomologist.

In form the aspen is rather pleasing, for, besides the unique character of the foliage, there is the added attraction of branches that tend to droop at their extremities, so that the tree has the appearance of those seen in old Japanese prints. The bark is smooth, roughened only slightly on the bole, except in very large trees, and the twigs, which are smooth and shining, are covered with yellow-brown bark. The buds are sharply pointed and sticky, differing in the latter respect from those of the white poplar.

The aspen, which is also sometimes known as the asp—a curious contraction which has no relation with that other asp, of Biblical and Shakespearean fame—is the subject of an ancient legend that seeks to explain the shivering of the tree's leaves. According to this old story,

H. Bastin

GREY AND WHITE

The leaves provide one of the characters by which the grey and the white poplars can be told apart. Those of the white poplar, shown here on the right, are covered on the lower side with a white, mealy down—hence the tree's name. In the grey poplar this down is less noticeable

it was an aspen that provided the timber from which Our Lord's cross was made, and the tree, gifted—or, it may be, cursed—with memory, perpetually shivers in remembrance of the purpose to which its wood was put. The poor quality of aspen timber at the present time is sometimes attributed to the same cause.

Combining in itself many of the characters of the aspen and the white poplar, the grey poplar is none the less a distinctive tree. It is thought to be native only in a few counties in the south-east of England. The leaves are hairy on their under surfaces, but the down is greyish, and much thinner than that of the white poplar; they may in rare cases be quite smooth. The build of the tree is similar to that of the white poplar, although it is not so tall, and it has the characteristic suckers found in both the other trees. The catkins resemble those of the white poplar, but the stigmas of the female flowers are four in number and are usually four-cleft at their extremities. The wood has the same useful features as that of the white poplar, and boards of it can be nailed without showing signs of splitting.

As the photograph at the bottom of this page shows, the bole of the grey poplar is also different from that of either the white poplar or the aspen. The fissures of the bark are not so deep, nor are there the same diamond-shaped markings which are distinctive of the former tree, while the differences between the grey poplar and aspen boles are also easily seen by reference to the photographs of typical examples below.

The poplars attract a most interesting insect fauna, and are the hosts of almost as many of our finest species as is the oak itself. Amongst the most striking are the puss and kitten moths and the poplar hawk moth, while a great many of our less-known moth larvae feed on poplar foliage.

POPLAR PILLARS

In the bole of a tree we may often find its most characteristic features; and here in these photographs of boles of (left to right) the grey poplar, aspen, and white poplar, we may see differences that cannot fail to be most useful in helping us to identify these closely-related trees when we meet them in the countryside

H. Bastin

H. Bastin

CATKINS OR CATERPILLARS?

Decorative in the extreme, the catkins of the white poplar, seen immediately above, are typical of the poplars in general. The right-hand photograph above shows the male (left) and female (right) catkins of the aspen, while what in the photograph below look like great, hairy caterpillars, are fallen aspen catkins.

M. H. Crawford

W. S Berridge

FOUND ON THE POPLARS

If trees could feel pride, there is no doubt that the poplars would be justly pleased at providing nourishment for the larvae of this magnificent moth, the poplar hawk. The commonest of our hawk moths, the poplar is remarkable for the way in which the wings are held when the insect is at rest, as seen in this picture.

In the rotten wood of older aspens and decaying white poplars, too, one may find the larvae of the wood-boring moths, such as the goat and wood leopard moths. Their adult insects may be seen sitting on the trunks, though their coloration is such that they are then very hard to find.

As in the aspen, a number of beetles live in the rotting timber of the other poplars. Beetles, too, may be found on the leaves of the trees, which are also the home of the larvae of one of our most notable saw-flies, whose caterpillars may be seen in great numbers on the foliage in the summer. Easily mistakable for those of butterflies or moths, they may be distinguished by their habit of rearing up the hind part of the body in a threatening manner when alarmed, and by the presence of a larger number of "pro-legs" than any lepidopterous larva possesses. Mistletoe is also often found on the poplars.

GROWING TREES FROM SEED. 1

One of the pleasantest points about our native trees is that they all have reasonably large fruits and are all fairly easy to raise from seed. To rear any trees from seeds we have ourselves collected is always something of an adventure, especially if we are lucky enough to be able to transplant them later on to a situation where we can watch them grow to maturity and eventually sit beneath the shade of their branches. Even for those who are forced, for one reason or another, to plant their seedlings in some far-off wood, there is a tremendous fascination in watching them grow through all the stages of their earliest youth.

Amongst trees that are especially suited to this purpose are the oak, the beech, and the Scots pine, all of which can be reared with very little difficulty, provided that we are careful to plant them in pots containing some of the soil on which the parent tree was found. In autumn we can pick up numbers of acorns which have the outer skin already split, exposing the strong, white root that will soon take firm hold once it enters the soil. Even acorns that as yet show no outward signs of germination will reward us; indeed, it is rather more entertaining to gather some of these and plant them carefully in pots.

Studying the Seedlings

If we take a good number, planting them all at the same time, we can dig up one or two at regular intervals and thus examine the way in which the young seedling is growing, long before there is any sign of activity above ground.

In the oak, moreover, we have a feature that is of importance botanically, for the two halves into which the acorn is split are nothing to do with the roots, as they might appear to be, but are really enlarged seed-leaves, or cotyledons, as the botanists call them. In many other trees the seed gives rise to a root that delves down into the soil, and an aerial shoot that strikes upwards, bearing first two cotyledons, leaves quite unlike those that are later produced. In the oak, however, the cotyledons are reserved as food stores to enable the root to get a better start in life. To prove this to our own satisfaction, we must wait until the oak seedling has sent up its aerial stem, when the first two leaves will be seen to be of the same type as those on the full-grown tree.

DOMESTIC DETAILS OF THE WILD RABBIT

RABBITS are such generally-encountered members of Britain's wild fauna, that it is difficult to believe that they have not always been denizens of our countryside, but were introduced from the Continent in possibly Roman times. Thanks to their extreme fecundity they have made good their hold, and there are few districts where "Bunny" is not accepted as part of the normal scene

NEARLY everyone is familiar with the common rabbit—with its long ears, soft, greyish-brown fur, and the great length of its hind limbs, which is the cause of its peculiar loping gait when moving slowly and of the quick bursts of speed of which it is capable when frightened or in danger. It is not so commonly known, perhaps, that the possession of the sharp, chisel-like front teeth with which it crops the grass is one of the sure signs that this animal is a rodent, and, as such, classed with the squirrel, the hare and the rat. The sharp front teeth, which are so conspicuous, are, of course, the incisors. These incisors differ from the other teeth in that they never stop growing, so that the amount of tooth that is worn down by their continual rubbing together is always being replaced. If any of the upper or lower teeth happen to get damaged or removed, so that the corresponding incisors have nothing to rub against, the unfortunate rodent is doomed to a slow death by starvation, for the sound teeth will continue to grow and will eventually penetrate the opposite jaw, thus effectively preventing the animal from feeding and condemning it to a lingering death, unless some chance puts a merciful end to its existence.

R. Hinkins

RABBIT-NIBBLED BARK

Though charming to look at, rabbits are not entirely harmless; this photograph, for instance, shows how a holly tree has had the bark of the lower parts of its trunk stripped by the sharp incisor teeth of these voracious rodents.

The dentition of the rabbits is the same as that of the hares, namely:

$$i\,\frac{2}{1},\quad c\,\frac{0}{0},\quad pm\,\frac{3}{2},\quad m\,\frac{3}{3} = 28$$

The fur of the rabbit is very thick and covers not only the whole of the body but the undersides of the feet as well, thus affording the animal a sure grip, whether on stone, grass or snow. The colour of the coat varies with age, being lighter in the young rabbits in their first year. Individuals also differ considerably, and occasionally one may see a wild black rabbit. Strangely enough, these black rabbits seem to be much more cautious than their lighter-hued brethren, as though they know that their colour renders them more noticeable. In all varieties, except in the black or in any wild descendants of tame varieties, the fur pales to white on the belly, and the under-surface of the tail is a conspicuous white. It was at one time thought that this white tail served as a danger signal to warn other rabbits, since it is always shown very clearly when the animal is running away; but since hares, which are solitary beasts, also possess a white tail, or scut, the validity of this theory is questionable. It is possible, however, that the hare was at one time a more gregarious animal than it is today, and that when it was forced to adopt a solitary mode of life the white scut persisted.

Tunnellers Through the Subsoil

RABBITS nearly always live in burrows, and prefer a light sandy soil in which to do their underground tunnelling. Although not especially adapted by Nature for the task of digging, they build large and extensive warrens to house their numerous progeny, and they will not hesitate to burrow in heavy clay soil and even hard rocky subsoil. They dig by scratching away the earth with their fore-feet and clearing the débris with kicks from their powerful hind feet. If stones intervene and they are unable to remove them by digging, they will try to dislodge them with their teeth.

So common is the rabbit in our islands that most people believe it to be indigenous to this country, but there is considerable doubt on this point; indeed, the rabbit is supposed to have been introduced by the Romans, who are also credited with the importation of the wild cattle, the pheasant and the edible snail. Rabbits were not common in Scotland until recently, but during the past hundred years they have increased rapidly.

The remarkable increase in numbers which rabbits generally show is due to their intensive breeding habits

C. Reid

THREE MONTHS' INCREASE

Rabbits are extremely prolific, having several families every year and anything from three to eight young in a litter, the larger litters being produced during the warmer months. This photograph shows a full-grown doe surrounded by her progeny.

and extreme fecundity. Young rabbits will start breeding in their first year, before they are fully mature and have reached their full size of 16 inches or so in length with a weight of two and a half to three pounds. Litter follows quickly on litter among the rabbits. Each family may contain from three to eight young ones, and as the breeding season extends throughout the warm summer months, each doe, or female, may produce four litters in a year.

If the rabbit population were not continually checked by the depredations of marauding animals such as foxes, weasels, stoats, badgers and owls, and also by shooting and trapping, it might well swell in numbers until it overran the whole country, denuding it of vegetation. The extent to which these small mammals can become a pest is well illustrated by the example of Australia, where the importation of rabbits and their subsequent increase, unchecked by natural foes, has led to the difficult problem of how best to keep their numbers down so that they do not ruin the grass.

The doe hollows out a separate burrow in which to bear the young, and lines it with soft fur, plucked from the underside of her coat. This is the only occasion on which a rabbit in the wild state uses bedding; normally, rabbits lie upon the bare floor of the tunnel. The young are born naked, blind and helpless, and it is ten days before their eyes are opened. After this they develop comparatively rapidly, and before a month is out they are capable of fending for themselves. It is during these early days that the baby rabbit is such an enchanting creature to observe as it sits outside its burrow, feeding on the tender shoots of the young grass. At the slightest hint of danger it will crouch down on the grass, making itself as flat as possible; anything may alarm it, from a

RABBIT-RIDDLED

Rabbits are communal animals and prefer to live in large warrens rather than in single burrows. If they are allowed to increase unmolested they will soon reduce a whole hedgerow or bank to the condition seen in the photograph below.

R. Hinkins

J. H. Vickers

WITH EARS PRICKED

When their suspicions are aroused, rabbits will sit at the mouth of their burrows, ready to disappear into the friendly shelter at the first sure sign of danger. That this particular rabbit is a young one is shown by the relative shortness of its ears.

breath of Man-tainted air to a suspicious sight or the sound of an old " sentinel " rabbit thudding out a warning message by stamping on the ground with his powerful hind feet. At this stage young rabbits may often be caught quite easily, since, although they seem to have learned the lesson of " freezing," or keeping still when mischief is brewing, they do not yet know the precise moment when all thought of concealment must be abandoned and safety sought in flight. All the same, it is advisable not to make any attempt to capture these babies, for not only are they easily frightened, but their delicate internal organs are very liable to be hurt by the rough touch of fingers made ungentle by the heat of the chase. Moreover, though they are easily tamed, it is difficult to keep them healthy, for the slightest mistake in diet upsets them, and they most usually die in captivity.

Watching families of rabbits at the warren is a fascinating pastime. The best time to choose is a summer evening, just as the shadows are lengthening, but while the sun still beats warmly on the grass. Then the rabbits come out and feed, stopping every now and again to wash their faces. Although the evening is the best, and certainly the pleasantest, time for watching rabbits, a great deal of rabbit activity takes place during the night. Rabbits seem to be particularly excited when the moon is full, the adults playing the most thrilling games, chasing each other in circles and jumping over each other's backs in the ecstasy of their delight. In these moments of sheer enjoyment the animals seem to be amply recompensed for a life which is one long hurry and scurry, threatened on all sides by continual danger, for it must not be forgotten how risky a rabbit's life is—indeed, the species has survived only by its fecund breeding.

ALL CLEAR?

On emerging from its burrow, a rabbit will sit up, displaying its scut, and survey the country before beginning to feed. This initial period of caution varies with each individual rabbit, and according as to whether or not it has suffered much from attacks of enemies.

M. H. Crawford

Rendered Brave by Mother-love

A RABBIT is not necessarily safe when it has reached its burrow; stoats, weasels and rats can penetrate to the depths of any warren even more easily than a rabbit. It may appear surprising, therefore, that any of the young rabbits survive at all, since they are utterly at the mercy of any invader, and can neither cry out nor move. The doe, however, is diligent in defence of her young, and, when worked up by a spasm of maternal solicitude, is quite capable of beating off any marauding stoat or weasel, for the rabbit has a formidable kick in its hind legs. It seems strange that the rabbit does not adopt a more pugnacious attitude on other occasions, instead of being, as it so often is, paralysed by fear. Only very seldom does an old buck rabbit put up a fight in which he manages to worst a weasel or a stoat.

B. Hanley

STILLED BY FEAR

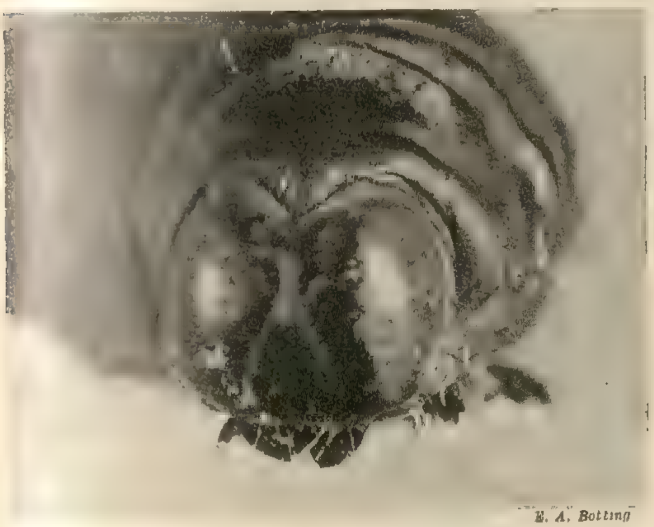
When alarmed at some distance from its burrow, a rabbit's first instinct is to " freeze," or flatten itself to the ground and remain motionless; by this ruse it hopes to evade detection by its enemies. The rabbit in this photograph is obeying this primal law.

The rabbit is not lacking in interest for those who wish to study its habits. Many of our birds and beasts can be studied only with great difficulty owing to their rarity or the inaccessibility of their habitat. Such is not the case with the humble " bunny," and it is well worth our while to spend some time in studying its habits.

NIGHTMARE FACES REVEALED BY THE LENS

Thanks to the microscope we are able to peer into the world of the exceeding small, to glimpse some of its remarkable features, appreciate some of its extraordinary wealth of beauty. And not beauty only. To many the photographs that accompany the chapter below will come as a revelation of the capacity of Nature to model masterpieces of horrific and macabre portraiture. These faces are indeed such as are seen in a nightmare phantasmagoria—yet in their creation no indigestible supper has played a part

In one of his earlier, pseudo-scientific romances, the novel entitled "The Food of the Gods," Mr. H. G. Wells told the story of the invention of a food that caused all who partook of it to grow to many times their normal size, and with vivid pen described the terrifying proportions of insects that throve upon this food, and how horrible they appeared to men. It would be a very alarming experience to meet such monsters in real life, and one that could be compared only to the worst of nightmares. Luckily there is little or no chance



E. A. Botting

MAGNIFIED FATUOUSNESS

Inspected through the microscope, the caterpillar wears a look of idiotic surprise. Contrary to what might be expected, the bulges on the side of the head are not eyes, although it is on these areas that the many *ocelli*, or little eyes, are placed (× about 12).

of such an eventuality, but it is possible to obtain some realization of the horror of an encounter with creatures such as he envisages by looking down a microscope and examining the heads and faces of insects and spiders.

Fearsome jaws, staring eyes and cruel pincers, all combine to give an impression of cold frightfulness and impersonal horror. Who can imagine a worse fate than that of being carried off by a giant spider, harassed by a blow-fly or the more delicate lacewing, torn by the jaws of a queen wasp, or crushed beneath the weight of a slow-moving caterpillar? But perhaps the worst horror would be the smell; imagine the appalling odour that would be emitted by an enormous cockroach! The microscopist can realize the ghastliness of such an idea, and can be truly thankful that these small invertebrates have never grown to a larger size.

It is a very easy matter to procure an insect's head and scrutinize it through a low-power lens, but at first the examination will be a little baffling. Insects have such a strange appearance that one is liable to make mistakes in identifying the various parts, and to see features which do not exist. Thus, in a photomicrograph of the caterpillar, the novice may be inclined to see eyes where there are only bulges on the head. An examination of the true eyes of the insects will reveal many interesting facts, the eyes of the queen wasp, for example, have multiple facets, so that, though the nervous system reduces the many impressions to one, the range of vision is tremendously increased by the wider angle that is gained. Though the fly can probably distinguish only light and shade and not form, it is enabled to perceive a moving object approaching from almost any angle, which explains why flies are so difficult to "swat." The

PORTENTOUS ROYALTY

A bristling and horrific appearance is presented by this face of a queen wasp. The two circular bosses in the centre of the forehead are the basal joints of the antennae, and the two rounded areas at the sides are the true eyes (× about 23).

E. A. Botting

A glance at the insect heads illustrated in this chapter will reveal many other interesting facts; the queen wasp, for example, has developed truly formidable jaws with jagged edges capable of crushing and rending her unfortunate victim. The blow-fly is equipped with a long but retractile proboscis which it uses for the purpose of tasting all the food upon which it settles; it is not surprising that this creature is loathed by the housewife as a pest, and is dreaded as a carrier of disease. In contrast the grasshopper appears as a genteel sort of insect, and its external skeleton is somewhat reminiscent of a medieval war-horse's armour. Nor is the grasshopper regarded as a pest by Man; indeed, the chirping noise that it makes in the grass by rubbing its legs and wings together is recognized as a cheerful summer sound. Coming to the last of our portrait gallery, the spider looks very much more objectionable through the microscope than when seen by the naked eye. Its long, creepy legs; its head, equipped with several pairs of eyes, with palps and chelicerae covered with stiff bristling hairs, make a picture well-calculated to cause a shiver of repulsion in the beholder who glimpses it through the eye-piece.

J. J. Ward

FLY FEATURES

The eyes, proboscis and antennae are well shown in this photomicrograph of the head of a blow-fly (× about 30). The large oval boss is an eye; where one would expect to find the nose are the antennae; the two club-like processes below are part of the fly's feeding equipment; and below these is the proboscis.

E. A Bolting

GRASSHOPPER PANOPLY

This is no picture of an armoured war-horse such as the crusaders rode, but a photograph of a grasshopper's head magnified about 12 times. Note again the eye and the out-thrusting antenna, while below the "cheek" is the three-jointed palp, with which the insect shovels in its food.

spider, on the other hand, has three or four pairs of eyes, but in spite of this it is unable to see very well, as its eyes are simple and weak.

We can readily realize from a scrutiny of these heads what an important part the antennae play in the life of insects, supplementing as they do their sense of sight with their sense of touch. How beautifully these antennae are fitted to the head, the junction of the basal joint with the head working in a perfect ball-and-socket fitting so as to ensure the free movement of the antennae! The full details of the structure and function of the antennae, the mouth-parts, chelicerae, poison glands and appendages of the arthropoda are dealt with fully in the chapters in this work dealing specifically with insects and spiders; the spider's mouth-parts, for instance, are illustrated in page 56, and the microscopist should study these before making a detailed examination of the creatures, so that he may compare their various mouth-parts and notice how exquisitely they are adapted to the life that each leads.

Some further points may be mentioned. It has been shown that wasps and flies have compound eyes that have multiple facets, and that these eyes give the creatures an exceedingly wide range of vision and so make them almost immune from attack. The antennae have also been developed into highly efficient sense-organs.

The arthropods are at the head of the invertebrates, and represent the highest and most specialized form of these backboneless creatures. Not only are they complicated and highly organized anatomically, but they seem in some cases to have evolved a social system of their own, with communal living and division of labour, which seems to parody closely some of the social institutions of mankind, unless, indeed, it be men who parody the insect world. It becomes clear that these marvellous little creatures came near to being a power in the world, through the high organization of their instinct or intelligence, or whatever higher centres they possess. Though one small creature is negligible, a mighty swarm, activated by some motive obscure to Man, may cause disease, devastation and death to a large part of the world-population, both animal and human. Thus locusts are still a source of trouble to Man today, costing him much labour and money, just as in the past their swarms descended upon the land, leaving famine in their wake. Even today there still lurks the fear of bubonic plague, when it is remembered how, in days gone by, swarms of rats out of Asia spread the disease throughout Europe through the agency of their unwelcome guests, the fleas.

A. W. Kerr

SPIDER HOBGOBLIN

Perhaps it is just as well that we do not see the spider as the microscope reveals it in all its unpleasant actuality! The beard-like appendages are the palps—the spider's jaws; the glittering beads are its eyes; and what look almost like arms are the chelicerae with which it grasps its prey (× about 10).

Although the idea of insects of giant size originated in the fertile imagination of Mr. Wells, insect domination is not so far removed from the probable. This brings one to the problem of why, having achieved a high state of organization—and that millions of years before Man appeared upon earth, and even before the first mammals fled before the fury of their overlords, the giant reptiles—they did not evolve still further until they attained the complete mastership of the world. The answer to this question must be sought within that shadowy region that lies between science and philosophy. The neo-Darwinians would assume that the insects evolved in that way because all the other variations were unfitted for survival, and that natural selection accounted for their precise position in the evolutionary scale. The neo-Lamarckians, on the other hand, would stress the inheritance of acquired characteristics. They would say that the accumulation of past traits would help to determine the future, and that characteristics acquired by the individual would be handed on until they became part of the heritage of the race.

ANGULAR LACEWING

The lacewing fly exhibits all the typical features of the Insecta, showing well the jointed appendages, compound eye, antennae and the forepart of the thorax. This profile photomicrograph gives a very good impression of the appearance of the forepart of its body (× about 8).

J. J. Ward

Growing more mystical, one might suppose, with Bergson, that there was a mysterious life force, an *élan vital*, and that this life force was expended upon the complicated anatomical structure and social organization to the detriment of both size and intelligence.

When changing from the scientific to the philosophic outlook, one becomes at once aware of the change from the factual to the hypothetical, and though some may now be inclined to doubt the reality of the material, it is always interesting to attempt to trace some connexion between the material and the immaterial, the substance and the essence. Thus if one supposes that the insects were checked in their development through the expenditure of their life force upon development that was uneconomical and unessential, one may then proceed further and draw a comparison with Man, and wonder whether the future of Mankind is not imperilled by an attention to the trivial and unessential. Many people will say that such a suggestion is hypothetical and cannot be proved; but neither can it be disproved.

Thus from an inspection of insect heads through the microscope we are led along fresh and possibly unsuspected paths of interest and of thought.

PROWLING TYRANTS OF OUR INLAND WATERS

THE voracious pike is the subject of the third study in our series dealing with the fishes that have their homes in the rivers and lakes of Britain. It is an unpleasant fellow looked at from the point of view of the other denizens of its habitat, and anglers, too, seldom have a good word to say for the pike. Yet, as will be seen from what follows, it makes a far from unattractive subject of study

ONE of the best-known and most widely distributed of the freshwater fish found in the rivers and lakes of the British Isles is the pike—a " solemn, stately, ruminant fish," as Thoreau called it.

Known to naturalists as *Esox lucius* (Lat. *esox*, pike ; *lucius*, an old Latin name for the fish), the pike goes by a variety of names in different parts of the country ; in the south of England it is often termed the " jack," and in Scotland and the north it is known as the " gade." Izaak Walton, in " The Compleat Angler," always refers to the fish as the luce, which is probably a corruption of the older name, lucius.

Fishermen's stories of the ravenous nature of the pike are almost as numerous and often as highly exaggerated as some of the accounts retailed by anglers of the sizes and weights of the fish of this type that they have caught. Apart from flies and earthworms, among the living creatures which have been said to fall victims to the hunger of this fish are moles, frogs, and even young moorhens, and it is true that there are hardly any types of bait used by anglers that have not been taken at one time or another by the pike.

This lurking terror of the inland waters is detested by all concerned in the preservation of streams where game fish are being bred and cared for. Numerous means are employed by keepers for the extermination of the pike, but it seems to be well-nigh impossible to get rid of it, for even in the most carefully-guarded rivers and lakes this fish can still be caught, thus showing the great powers of survival it possesses in the relentless and never-ending struggle for existence.

BUT in rivers not set aside for the joys of trout fishing, such as the Lea, the Thames, and the Trent, pike are not regarded as pests, and are accorded the same consideration as the other inhabitants of the waters. In these rivers fishing for pike during the breeding season is just as much a breach of the fishery laws as the poaching of salmon or trout.

The amateur fisherman may easily recognize the pike by the great length of its body and the enormous size of its jaws. The mottled brown and green coloration of the fish makes it extremely difficult to see among the reeds and water weeds of the stream, and this blending of animal with background is an excellent example of protective colouring in Nature.

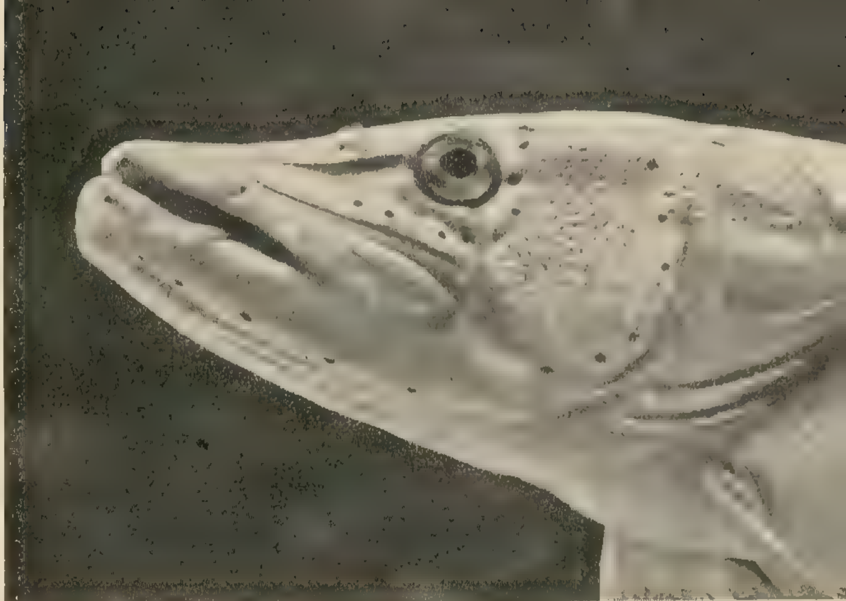
TERROR OF THE STREAM

The pike has a well-deserved reputation for ferocity, and is often found leading a solitary life in a section of the lake or river over which it has complete control. Many reliable authorities record cases of pikes devouring salmon of their own size, while in some parts of the country bathers have been attacked and badly bitten.

Neville Kingston

For anyone unused to looking for fish under water, a drowsing pike among the reeds and stones may be very difficult to find. It is by means of its colouring that the pike is able to approach within a few inches of its victims without arousing the slightest suspicion.

Years ago it used to be believed that pike were the product of spontaneous generation, for the actual process of pairing is not often seen, since it takes place in out-of-the-way backwaters, dykes, and shallow pools. Even Walton, the expert, credited this tale with the comment: "'Tis not to be doubted but that they are bred, some by generation, and some not." Pike pair, however, just like any other fish, mating in February and the females spawning in March and April. In the very early spring the pairs may be seen together selecting places for spawning, and, if they are very carefully watched, the mystery of the birth of these fish may be completely and speedily cleared up to the observer's own satisfaction.



Neville Kingston

PIKE PHYSIOGNOMY

The head of the pike, with the most powerful jaws seen in any British freshwater fish, is well studded with the tiny holes which represent an extension of the sense-organs of the lateral line along the side of the fish. The head of the pike is greenish in colour, while the throat and underparts of the body are white.

An interesting fact that has only recently been disclosed by the research work of naturalists is that many pike go out to sea for spawning, and that during this season the brackish waters of river estuaries and distributaries abound with the fish. Of the adults, the youngest spawn first, making their way to the shallow water for the purpose. The females, which are much larger than the males, deposit up to as many as 600,000 eggs. These are left to lie free on the bottom, and are sometimes to be found in such temporary waterways as flooded grasslands and sunken ditches. Immediately after deposition the eggs are feebly adhesive, but they soon lose this quality and float near the bottom, rocked by the currents of the water and driven hither and thither by the eddies set up by passing fish of other kinds.

The young fish hatch out within about fourteen days, and remain as larvae in the shallow water, swimming about near the surface until the yolk-sac, which is still attached to them, is finally absorbed, this taking about ten days or even more. At this stage they begin to seek food for themselves, and set off in search of deeper water and of more attractive prey than that met with near the surface. Only a very few months elapse before the young fish reach the adult stage, when they assume the characteristically deceptive colouring, with yellow spots or wavy bands at the sides, and the dorsal and caudal fins covered with dark spots or stripes.

NOT QUITE ASLEEP

Like most of the very powerful animals, the pike takes great delight in prolonged periods of slumber. The slightest disturbance of the water, however, will immediately waken the sleeper to his more usual state of voracious activity, and woe betide any little fish that then comes his way.

A. H. Jacob

Pike swim about just as much in the winter as in the hot summer months; and sometimes a skater, when passing over thin ice which is clear enough to allow of a view of the water underneath, may see large pike devouring the smaller fish which are unable to get out of their way because of the hanging sections of the ice. Pike have been known to eat their own kind in times of need, and that well-known writer on angling, Walter Gallichan, relates how he once saw through the thin ice upon which he was skating an enormous pike "carrying in its jaws a fish of its own species." Pike like to lie hidden among the weeds and undergrowth of the stream rather than range abroad as do trout. In the Norfolk Broads they spend most of their time among the stems of the thick reeds which fringe the open stretches of water, and fishermen, before beginning their day's fishing, often expel them by means of dogs specially trained for the purpose.

Walton described the pike as a "solitary and melancholy" fish, for it selects its feeding places with the greatest care and guards them jealously from all invaders. Only in the twilight of the summer evenings do pike make excursions into the shallows where they might otherwise be seen from the land, and, taking advantage of their colouring and the dusk, pursue small fish and devour them in hundreds. Darting at the passing fry, the pike quickly seizes

more fish are caught in this way than were ever landed in the old days.

From the well-recognized fact that a large number of pike may be caught on one day and a very small number only a few days later it would appear that pike feed very greedily for a while and then fast for a day or two. They are easily caught in times of frost, for the low temperature sharpens their appetite; but they are usually most hungry immediately after the spring spawning period, when they return from the spawning grounds thin, dull in colour, and unfit for the table.

The usual methods of catching pike are trolling, spinning, and live-baiting. They can, however, be taken by means of a ring of wire fitted to the end of a pole. The pike is sought out and carefully watched until it is lying quietly in open water, where it may be caught. The pole is thrust into the water several feet in front of the pike and the ring of wire carefully slipped over its head. When the ring is about at the middle of the fish, a sudden jerk is given and the pike is thrown on to the bank.

GOOD CATCH

Pike are caught with rod and line in many of the lakes and large rivers of Britain. In the photograph above a weighty catch has just been landed with the gaff and is about to be dispatched. This photograph was taken on the Broads.

one of them in the middle, holding it crosswise in its powerful jaws for some minutes before actually swallowing it.

Before the now usual method of "strike" fishing came into use, the angler would give the pike some eight to twelve minutes before pulling in the line. Today, however, when the principle of fishing is somewhat changed, the angler "strikes," or jerks quickly, at his line as soon as he feels the pike move the bait. Modern "snap-tackle" and the arrangement of the hooks on the line have made this possible, and a great many

SPECIMENS as heavy as 35 to 45 lb. are by no means an uncommon catch in a good pike stream. The question as to who has the honour of taking the record pike still seems to be an open one. Edward Fitzgibbon, the Irish writer, stated in one of his books that he believed the largest pike ever caught in Britain was one landed from the river Shannon, at Portumna, weighing about 92 lb.

Revealers of Nature. 11

LUKE HOWARD

THE year 1783 was a thrilling one for sky-gazers. First, there was an unusual summer haze, with a remarkable display of the Aurora Borealis—these phenomena were remarked on by many, including Cowper, in his poem "The Task," and Gilbert White, who mentions them in his "Natural History of Selborne." Then there was the incidence of a great meteor that passed over Britain from north to south. But of all the people who must have noticed these events only one—a certain Luke Howard, a boy of 11, son of prim Quaker parents, and then engaged in absorbing the Latin grammar, which he admits be hated—was inspired by them to pursue the subject further. Luke was the son of a London ironmongery manufacturer. On attaining his majority he became a chemist and druggist in London, and from the practical science of chemistry he passed to the study of botany. But his first love was meteorology, of which he is reckoned one of the founders; from his childhood he had been interested in the sky and the weather, and even as a schoolboy had set out the basis of his celebrated classification of the clouds.

Howard's "modification of the clouds" was first published in a technical magazine in 1803. He divided clouds into three primary types: cirrus, cumulus and stratus, with the four subordinate compound types of cirro-cumulus, cirro-stratus, cumulo-stratus and cumulo-cirro-stratus (better known as nimbus or rain-cloud). The names he took himself from the Latin, and they have been used in the main by meteorologists ever since. Three years later, in 1806, he began to keep a register of meteorological phenomena—one of the first of its kind in England—the facts of which were published, with further remarks on cloud classification, in 1818-20 as "The Climate of London."

Howard's registers are of great importance, for they are the only existing meteorological records of the early 19th century. Others of his meteorological works are "Seven Lectures on Meteorology," "A Cycle of Eighteen Years in the Seasons of Great Britain" and "Barometrographia: Twenty Years' Variation of the Barometer in Britain." These were pioneer works; the elaborate system of weather-forecasting now used throughout the world and instrumental, through wireless-broadcasting, in saving lives and property from damage by storm, was in Howard's day less than a dream. It must not be supposed that Howard invented scientific weather-forecasting or even visualized it; his instruments were crude and inefficient, and he had not the advantage of the delicate electrically controlled mechanism of modern meteorologists. But he pointed the way to a system of recording climatic facts and vagaries; he drew attention to the interesting variety of the sky; and he showed that patience and method had a very real reward in the value of minute observation and chroniclings of apparently insignificant and unconnected phenomena.

A stern Quaker, Howard published other works than his meteorological tracts; among them were a pamphlet denouncing profanity and swearing, another attacking the evils of imbibing spirituous liquors, and another on the kind treatment of animals. He was a practical philanthropist and went to Germany to distribute funds subscribed in England to relieve peasants suffering there in the Napoleonic Wars. He also frequently corresponded with Goethe, who thought highly of him. Yet within a few years of his death, which occurred in 1864, he was well-nigh forgotten—his only memorial the passing clouds that he had named.

HABITS AND HAUNTS OF THE PLAYFUL OTTER

COMPARATIVELY few of the rambling multitude ever have the good fortune to espy an otter family frisking in the water—not because otters have so dwindled in numbers as to be in any degree rare, but because, for the most part, only the experienced naturalist knows just where to find the otter haunts and how to approach the animals without frightening them by his presence. Many facts about the otter tribe are given below

MANY people think that the otter, known to the naturalist of today as *Lutra vulgaris*, is practically extinct in present-day Britain. This is not so, however. There are probably just as many otters fishing our rivers and streams now as there were in the 17th century, when Izaak Walton wrote his account of the discussion between Piscator and the otter huntsman. "Sir," said the huntsman, in reply to the question whether he hunted beast or fish, "it is not in my power to resolve you; yet I leave it to be resolved by the College of Carthusians, who have made vows never to eat flesh . . . her tail is fish, and if her body be fish, too, then I may say that a fish will walk upon land."

Although in taste otter flesh is very similar to that of a fish, and the tail and webbed feet are even more suggestive of a truly aquatic animal, the otter is actually a carnivorous mammal closely allied to the stoats and weasels, and, like the seal, provides an example of a land-living animal which has found for itself a home in the water. Its food mainly consists of eels, trout, salmon, pike and flat-fish, but mussels and limpets, frogs, wild duck and rabbit also enter occasionally into its menu.

FOR hundreds of years the otter was looked upon more as an animal to be hunted with a pack of otter hounds than as an interesting zoological specimen. In the present century the sport of otter hunting is fast becoming a thing of the past, and where trout and salmon streams have to be protected from the ravages of this natural fisherman, traps and guns are used in place of dogs.

The body of the otter is long and lithe, and is clad in a fine pelt of smooth fur. The animal has a long, tapering, though thick tail, which gives it a very graceful appearance in the water. The head is somewhat broad and flattened on the top, the face short, and the eyes smallish but very bright. The ears, too, are small; they are covered with hair and formed in such a way that they become closed when the animal is under the water. The legs, having been adapted for swimming, are short and very powerful; the feet are large, five-toed and webbed. Each of the toes has a short, pointed claw, but those on the hind feet are slightly blunted, being flat and nail-like in formation. The dental formula of the otter is:

$$i\,\frac{3}{3},\ c\,\frac{1}{1},\ pm\,\frac{4}{3},\ m\,\frac{1}{2} = 36$$

The six molar teeth have sharp, tubercle formations on the crown, which are utilized in biting through the hard scales of fish entering into its diet.

STURDY SWIMMER

The webbed feet and flattened tail of the otter are well-suited to the animal's aquatic existence, for by their means it is enabled to swim both on the surface and under it. The position assumed when swimming on the surface is well illustrated below.

A. R. Thompson

Frances Pitt

STARTING OUT TO FISH

The thick, glossy hair with which the fine, soft fur of the otter is interspersed provides the animal with a water-tight coat. Hence, though the otter may remain in the water for hours at a time, its skin never even gets damp. The otter seen above is Miss Pitt's pet, "Madame Moses."

The pelt of the otter is made up of two kinds of fur. An under-layer of soft, fine hairs, whitish-grey in colour, is so closely matted that, although the otter may remain in the water for hours at a time, the actual skin of the animal is never even damp. Interspersed with these fine hairs are others, which are longer and far coarser. These compose the second pelt, which acts as a means of protection and takes on that glossy appearance so typical of the otter when out of the water. These longer hairs are grey at the base, but become darker towards the tips, so that the otter as a whole has a brownish coloration, though on the cheeks, the throat and on the underpart of the body these hairs have a much greyer tint.

Naturalists, it is true, have recorded white, cream and even spotted examples, but these are undoubtedly rare variations, occurring for the most part in Scotland, where climatic conditions may have much to do with their appearance. In Ireland there is a distinct tendency towards darker colouring, some specimens which have been recorded there being so dark as to be almost black above and blackish-brown below. The muzzle of the otter, apart from the covering of hair, is also provided with stiff *vibrissae*, or whiskers, which are so thick as to be almost quill-like.

Like most of the animals which are hunted in this country, the otter has a terminology of its own. The five-toed footprint, on which the edge of the webbing of the foot can be clearly seen, is known as the "seal" or "spur" (cf. "spoor"). The lair, known as the "holt," is always built near water, while sometimes the entrance, like that of the beaver's lodge, is actually situated below the surface. In order to look for an otter's holt, the rambler is advised to go by day along the banks of a stream and to keep a sharp look out for the seal as well as the droppings, which are known as "spraints." Having once located a holt, it is best to return home and come back again at nightfall, when the otter, which in this country is almost entirely nocturnal, will be abroad in the river, hunting for fish.

If the rambler goes by night to an otter's holt in the late spring, he may be lucky enough to catch a glimpse

DOWN FOR A DIP

Otters generally, and especially the cubs, are very playful animals, and the two young ones in the photograph below are preparing to leap from the steep bank into the stream. The bitch otter sometimes makes a mud slide for her offspring's amusement.

of the father or dog otter fishing, while the mother teaches the young to emulate their father. A shrill, whistling noise may sometimes be heard, which is the cry of the otter when contented at play, while a faint whimpering is an indication that all is not well. If really alarmed or excited the otter will give a shrill bark, not unlike that of a puppy, and this may be varied on occasion with a kind of whistling call.

Otter Cubs in the Nest

ALTHOUGH the otter cubs may be born any time throughout the year, the bitch usually "whelps" in the spring. A litter numbers from two to four, but sometimes as many as five or even six cubs have been discovered. When the young are about to be born the mother otter builds a nest for herself at the back of the holt, or even in a completely new part of the river, where a hole in the bank or a hollow tree may be found. This nest she lines with soft, dry materials such as grass and rushes, relying on the dog otter for protection from her enemies.

When born, the young cubs are blind (remaining so nearly two months) and are richly covered with a fine, downy fur. The mother suckles them with her two mammae throughout the first few weeks of life, but they are soon able to digest more solid food, and both the dog and the bitch go out fishing for their young. Otters are peculiarly playful creatures, and love nothing so much as a frolic with their babies.

ERECT AND COUCHANT

The two pictures in this page show clearly the typical features by which the otter may be identified. The round head, whiskered muzzle and short ears, as well as the webbed, five-toed feet and the coarse hairs on the back and sides, are clearly in evidence.

H. Bastin; V. Kingston

A. R. Thompson

AN OTTER HAS PASSED BY

During the frosty months of winter many animals in search of food take to the frozen, snow-covered surface of river or lake, leaving tracks by which they may easily be identified. The story of the "spoor" (from front to rear, otter, fox and rabbit) seen in this photograph is told in the note at the foot of this page.

The parents do not remain together for very long, for as soon as the cubs are able to swim and dive the dog goes off on his own, leaving the bitch to care for the family during the remainder of the summer. Now it is that he wends his way across country, often so far away from any water that he is compelled to change his diet and subsist for a time on moles, small birds, beetles and grubs. After some months he may even reach the coast, and, changing his diet once again, hunt for sea-fish in the rocky pools of the shore. With the return of the "rutting" season in the winter, he retraces his steps inland until he reaches an otter stream, where he fights with the other males until he has managed to secure for himself the female of his choice.

In spite of the amount of time spent by the otter on land, the animal is essentially aquatic, swimming and diving with great facility. In the water it propels itself with all four limbs, the strong tail being used as a rudder. It swims in a nearly horizontal position with the nose just above the water, but when searching for fish much of its time is spent below the surface, where it may remain for about a minute at a time.

ALTHOUGH local in its distribution, the otter is found in diverse districts throughout the British Isles, but it is most common in the Lake District, the rocky parts of Somerset, Devon and Monmouth, East Anglia and in some parts of the Thames valley.

HOW TO STUDY ANIMAL 'SPOOR'

Tracking and the examination of the "spoor," or footprints, left by animals on the ground is a sport with which the amateur naturalist can amuse himself at all seasons. The autumn and winter are, however, the most suitable times of the year, for in these months the ground is either soft from rain or is covered with frost or snow. The advantages of snowy ground are manifest, but if the snow lies very thickly the depth of the markings may make recognition by even the most highly skilled trackers a somewhat arduous task. In the case of very large and heavy animals, e.g., horses and cattle, the thickness of the snow does not matter a great deal, for the length of their legs overcomes the difficulties of walking or running. Smaller animals, on the other hand, sink into soft snow, so that the trail is either entirely obliterated or definitely abnormal.

The very best trails are such as those shown in the photograph at the top of this page, where a thin layer of snow has fallen on the frozen surface of a lake. Here a hard, smooth under-surface and a light fall of snow have provided the ideal trail-making conditions. In the foreground the five-toed "seal" of the otter can be seen. The lake having been frozen over, there is no chance of fishing, and the otter has been forced to go in search of other food. He will probably endeavour to catch a moorhen or a wild duck, but may have to be content with nothing better than a toad dug laboriously out of the ground.

What the Footprints Reveal

The "spoor" in the background tells the story of a rabbit's expedition in search of an area of grass uncovered by snow. Timidly it crept along the ice, keeping near to the trees overhanging from the bank, but its scent was soon taken by a fox (centre spoor). Reynard followed it, however, in the wrong direction, going from the right of the picture to the left. This may have been due to the fact that the trail was an old one and the scent faint, but the more likely explanation is that the fox was endeavouring to find its way to the warren from which the rabbit originally emerged.

One of the best ways to learn the meaning of spoor is to watch the animals themselves making their tracks, and then to draw diagrams of these tracks in a notebook. Practically every animal has some distinguishing characteristic about its trail, and should the actual spoors fail to reveal the identity there is no reason why other signs should not be relied upon. A broken or nibbled green stick is often the sign of a rabbit, while the scent of a fox is only too evident even to the most insensitive noses. The droppings of animals are another invaluable clue, and these, taken in conjunction with an examination of any hairs left on the twigs of bushes, are often the sole evidence upon which the tracker can rely during the summer months.

Tracking is a sport of which the amateur naturalist need never grow tired, and at which no one can consider himself perfect, even after years of practice. There is so much to learn, so many little hints to be gained from experience, and the conditions are so variable, that a lifetime may be spent before anything approaching perfection can be attained by even the most astute.

BLUE FLUTTERERS OF THE CHALK DOWNS

THOUGH denied the gorgeous hues of some of the larger members of the butterfly tribe, the "Blues" described in the chapter that follows are lovely little creatures, always hailed with delight by the wanderer over our incomparable downs. They are reproduced in colour and almost life-size in the plate facing page 37

Of all the many types of country that are popular with the rambler none has so special an appeal as the chalk downs, and this appeal extends to all who, besides enjoying the exhilarating air of the downs, are attracted by the creatures of the countryside. The English chalk hills have a very markedly characteristic fauna and flora, and they are especially rich in butterflies. Many of our loveliest and most decorative species are almost confined to districts whose chief features are the chalk hills, and of none is this more true than of the various Blue butterflies. One of these, and perhaps the most beautiful, is associated by its name with the downs; this insect, the Chalk-hill Blue, is one of the first prizes of the young collector, for its local occurrence combines with fine colour and strong flight to make it one of the most attractive insects.

The Blue butterflies show extremely well one of the features characteristic of the majority of butterflies and moths, that is, the marked difference in colouring between males and females of the same species. In the Blues the characteristic colouring is practically confined to the males, and the females, although beautiful in their own way, are of a general dull brown colour, which compares most unfavourably with that of their mates.

In the Chalk-hill Blue this is well seen. The male (Fig. 39, plate facing page 37) is unmistakable; no other butterfly has the same wonderful silvery greenish-blue tints on the wings, and few are so strikingly handsome either at rest or in flight. The wings are edged with a blackish-brown margin, beyond which is a border of pure white. The veins of the wings show up black through this white border, and the margin of the hind wings is broken by a number of black and white eye-spots of the type common in most Blue butterflies. The underside, also very characteristic of the type, is greyish, with black eye-spots along both margins, and a number of similar spots and black markings over the inner areas of both wings. The marginal eye-spots of the hind wings often have orange crescents on their inner edges.

The female of the Chalk-hill Blue is dark brown above, with sometimes a smudge of blue on the inner areas of

IN SUN AND SHADE

When the sun is shining brightly the Chalk-hill Blues flutter merrily (below, right), but when it is temporarily overcast they settle and fold their wings (left). In each photograph the male (top) is obviously more resplendent than his spouse. (Approx. life-size).

J. J. Ward

S. F. Waters

PATTERNED BEAUTY

Here we see, enlarged about three to four times, the lovely underside of the Common Blue butterfly when at rest. White fur clothes the legs and body, and white rings surround the black spots on the pearl-grey wings.

the fore-wings and black spots in the centres of both wings. The margins are white, and along the rear border of the hind wings is a series of eye-spots, whose inner edges are usually bright orange. This orange and brown coloration is characteristic of the females of all the Blues, and, indeed, it is often very hard to tell the difference between the various species. The underside of the female is similar in markings to that of the male, but brown where the male is greyish.

All the caterpillars of the Blue butterflies are small, fat, and generally green in colour, covered with a number of black hairs and bristles, and they feed on various plants that form the low-growing and compact herbage of the downlands, especially plants of the pea family. In the Chalk-hill Blue the eggs are laid late in the year, to give rise to caterpillars in the following spring, but sometimes there are two broods, one in the spring and one in the autumn. From their small size, and from the ease with which perfect specimens of adult insects may be obtained on the wing, these caterpillars are not so popular for breeding purposes as are those of most of the larger butterflies.

Next to the Chalk-hill Blue in beauty is the Adonis or Clifden Blue, which earned its second name from the fact that it was first observed at Clifden in Buckinghamshire. This butterfly (Fig. 47, plate facing page 37) is of a brilliant blue colour, occasionally tinged with purple or green. There is a white border to the wings, inside which is a thin black line; the veins again show up as black lines running to the outer edges of the wings. The female is dark brown, sometimes almost black, with marked orange crescents or eyes round the edges of the hind wings, and sometimes also of the fore-wings. The underside is similar to that of the Chalk-hill Blue, but with rather more orange in the spots and ring-markings. It is smaller than the Chalk-hill Blue, the wing span of the

A. E. Tonge

BUTTON-LIKE EGGS

Round and flattened, covered with a beautifully symmetrical arrangement of little depressions, the eggs (× 23) of the Common Blue butterfly seem like tiny buttons or even cheeses. Their form, typical of the Blue group, is very different from that of the eggs of the marbled white or clouded yellow shown in page 315.

male being not more than $1\frac{1}{4}$ inches as opposed to almost $1\frac{1}{2}$ inches in the other insect.

Less widely distributed than many of the other Blues, the Clifden Blue is found on the chalk hills of the south of England, and in many places where there is limestone rock, on which is found the horseshoe vetch—its larval food. The way in which the distribution of its food plant acts as the controlling factor of the distribution of the insect is a feature that we find again and again in the life stories of our butterflies.

'BLUE' SERIES

In the top row of the photograph directly below are shown the male (right) and female (left) of the Common Blue butterfly, while beneath these are represented their undersides. The left-hand picture of four specimen Blues shows the way in which the markings on the underside may vary (slightly larger than life-size.)

A. E. Tonge

Another Blue that is local in its distribution but fairly common on the chalk hills is the Small Blue, also known as the Little Blue or Bedford Blue (Fig. 57, in colour plate facing page 37). This is an unmistakable insect. The smallest of our butterflies, it is of a dark sooty-brown or blackish colour, with sometimes a powdering of blue over the inner areas of the wings; this feature is, however, confined to the male insect. The underside is silvery-grey in colour with an outer row of tiny black spots, each surrounded by a white ring: there is a single central spot on the fore-wings, and a number of similar spots on the inner area of the hind wings.

In England the Small Blue is found normally in late spring and early summer, when its smoky little form may be seen flitting about warm, sunny hollows and grassy slopes. Like many of the Blues, it occurs chiefly on limestone hills, especially the chalk in the south of the country; its scarcity is more imaginary than real, since it is so insignificant that many young collectors will pass it over completely.

As its name implies, the Common Blue (Fig. 51 in plate facing page 37) is the most frequent of our native species; it is, in fact, a butterfly which almost everyone must have noticed. On the chalk hills, however, this insect, too, is found at its best, and it is possible for a collector with a certain amount of time to spare to acquire an extraordinary range of variety in coloration and marking in this species. The caterpillars are not so fastidious in their choice of food plant as are those of many of the other Blues, a fact which no doubt accounts for its wide distribution; they will feed on many plants of the pea family, such as clover and bird's-foot trefoil, and especially rest-harrow, as well as on plants from other natural orders.

ARGUS TO BE

Here are two Brown Argus pupae, seen from above (top) and from below (lower picture). In form they are typical of many pupae of the Blue group of butterflies (× 2).

The male of this insect is brightish blue in colour, but not so bright as ever to be confused with that of the Clifden Blue; there is normally a faint tinge of purple or violet in the blue. The wings have a narrow black edge, with a white fringe. The female is brown, usually with a slight powdering of violet-blue, and in some cases the whole insect is as much blue as it is brown. Along the outer edge of the hind wings there is very often a row of orange markings; these, which vary enormously in size, may also be found on the fore-wings, and may have black central spots.

A complete range of specimens of the Common Blue will show a series from the pure blue male, whose colour may faintly resemble that of the Clifden Blue, to a female

A. E. Tonge

PLUMP AND HAIRY

The larva of the Brown Argus—in spite of its name it is one of the Blues—is short and fat and rather hairy, thus differing considerably from those butterfly larvae which are seen in earlier pages. Typical of the group, it feeds on the rock rose, and is therefore rather confined in its distribution ($\times 2\frac{1}{2}$).

whose wings combine large orange spots with a thick blue powdering. The undersides of both sexes show the typical ground colour with black and white eye-spots that has already been noted. Giant and dwarf specimens are often found in both sexes, and the males are, as in most of the Blues, normally a trifle larger than the females; the size is the same as the Clifden Blue.

In spite of its name, the Brown Argus is closely related to the Blues, as a glance at its underside shows. The upper surface of the wings, however, is of an almost uniform brown colour, with a well-marked series of orange spots round the margins The ground colour of the underside is browner than in the other Blues, and the spots of the inner area are often entirely white; there is also more orange than is found in most of the Blues. It is a two-brooded insect, and is found chiefly in districts where its food plant, the rock rose, grows. In the colour plate facing page 37, No. 34 shows the Scottish variety of this butterfly, distinguished by a white spot in the fore-wings.

In common with the other Blues, the Brown Argus is fond of resting on the stems of grasses and this gives a great opportunity for the examination of individual specimens. The insects always rest so that the wings, which are held upright over the back, point away from the wind, and by moving up-wind over the area where they are, we can be sure of examining every insect without meeting the same one several times. By taking them carefully between finger and thumb, and pressing slightly on the sides of the thorax, we can open the wings and thus examine both under and upper sides. This device is very useful as a means of collecting a large range of the Common Blue, and is best practised on dull or windy days when the insects will not be on the wing.

COMMON BIRDS OF THE REED BEDS

OF the birds that have their homes among the reeds and sedges that line the banks and sometimes cover the floor of our inland waters, the species dealt with in this chapter—the reed warbler, the sedge warbler, and the reed bunting are the most easily-discovered. Other denizens of a similar habitat, birds which are far less frequently encountered, are the bittern and the bearded tit, reserved for treatment in later chapters

THE great beds of reeds that spread over large spaces in most estuarine districts form some of the happiest hunting grounds of the ornithologist. In Norfolk especially the areas covered by reed beds are so extensive that they form admirable natural sanctuaries, being the sole remaining localities in which many of our rarest and most interesting birds are found. Such places are not easily accessible to the average rambler, and in most cases the best areas are now strictly preserved against the ravages of collectors. The present chapter deals with birds which may be found living in the smaller beds of reeds and rushes lining the ponds, rivers and canals throughout the country, and may there be seen by anyone who cares to look for them. The rare birds of the Norfolk reed beds are treated in a later chapter.

FOR the Nature-lover there is always a peculiar charm about the banks of a pond or stream, whatever the season of the year, and in spring this attractiveness is heightened by the fact that there is scarcely a single patch of reeds or rushes without its quota of nesting birds. To the gentle murmur of the stream and the rustle of the reeds there is now added a continuous sound of bird song, for several of the avian inhabitants of the riverside are energetic songsters, though their songs have little musical merit.

Two of the most notable of the reed birds, at least in so far as their songs are concerned, are the reed warbler and the sedge warbler, and both have a charm that is irresistible to anyone who has once made their acquaintance. In habits and song they seem rather similar, particularly to the rambler who discovers them for the first time, but the difference in their appearance can easily be recognized with a little practice.

The reed warbler is brownish with an olive tinge, shading to slightly reddish on the rump. The tail is rounded and the wings are a little more greenish than the rest of the body. The underparts shade from white on the chin and throat to buff on the stomach. Over the eye there is a light-coloured stripe. This coloration is so drab and quiet that it is often difficult to pick out the bird from the waterside vegetation among which it spends its days, even when its characteristic song can be heard close at hand.

ONE of the loveliest to be found in the British Isles, the reed warbler's nest is woven cunningly round three or four reed stems. Typically, it is suspended rather than supported; in other words, it is nearly always slung over the water, and seldom actually rests on reeds that are growing on firm mud above the water's edge. Usually it is rather

HOME IN THE REEDS

Few nests to be found in the British Isles are so cunningly constructed as that of the reed warbler. Woven of grasses and built round the stems of the reeds, it is made very deep so as to prevent any possibility of the eggs and young ones falling out when it sways in the breeze.

Ian M. Thomson

S. V. Waters

DEPTH FOR SAFETY

Deep is the nest of the sedge warbler, for it is placed among herbage or in low bushes where the eggs might easily be shaken out by the wind. Grasses are used in the construction of the nest, and the eggs, thickly mottled with pigment, are typical of those produced by members of the warbler group.

deep, and firmly built, the materials being grasses and strips of the reeds and sedges; the feathery flowers of these are employed to make the whole structure more compact, and wool is sometimes used for the same purpose. So deep is the cup of the nest that often the head of the bird is only just visible over the side, and even when the stems are swaying in a strong wind the eggs or young birds are perfectly safe. Occasionally a pair of birds—lazier, perhaps, than their fellows—will build a slight and very shallow nest—so slight, indeed, that the eggs can be seen from below. The eggs, four or five in number, are laid in late May or June; their greenish ground is almost obscured by blotches of stronger green and grey. The reed warbler is one of the many birds that are victimized by the cuckoo. A lusty young cuckoo, when it begins to grow up, severely taxes the delicate nest, while the small grubs and aquatic creatures that satisfy the appetites of the baby warblers must seem very meagre fare to so large and hungry a youngster.

Although its appearance is so plain, the reed warbler seldom passes quite unnoticed by any moderately observant person, for it maintains an almost continuous chattering during the daytime, as it flits and hops from reed to reed, sliding down the stems in search of insects, which it picks daintily off the undersides of leaves or even off the surface of the water. The song, too, betrays it sooner or later, for if the birds are disturbed by a noise in the reed bed they will often sing, either from nervousness or as a means of signifying their disapproval. The song itself is not particularly notable, for although some of the notes are sweet, they are mixed with others that are harsh and grating and unmusical, and the whole performance is delivered in an uninterested manner. The reed warbler may be likened to a man who, though he is not musical, sings at his work because he is happy, but is incapable of expressing any of his feelings in his song.

It has been mentioned above that the songs of the reed warbler and the sedge warbler seem somewhat alike, but this is the case only when we are not familiar with the two birds. Actually, the sedge warbler is a much more energetic singer, although an equally erratic one. It sings in snatches, and then is quiet for a long time, and its song is often so mixed with alarm notes and call notes that it becomes a continuous jumble of noise. Frequently, however, we hear notes of a surprising richness and fullness, and these, coupled with the bird's fondness for singing at night, have led to its being mistaken for a nightingale. The notes of other birds, as well as many miscellaneous sounds, are mimicked by the sedge warbler and introduced into its song, and the combined effect of all these factors reminds one of the kind of musical medley in which the second excerpt is begun before the first is finished.

AMONG THE SEDGES

The sedge warbler's nest is not woven round the stems of plants as is the reed warbler's shown opposite, but normally is supported by them, as in this example. The bird's neat form and characteristic eye-stripe are easily seen—points which help to distinguish it from the plainer reed warbler.

Ian M Thomson

S. Crook

SHELTERED SITE

The curving stems of a tuft of rushes serve to roof this reed bunting's nest, and shield it from the eyes of aerial enemies. The sombre plumage of the little hen bunting is in striking contrast to that of her handsome husband, revealed in the photograph in the opposite page.

Reddish-brown is the preponderant tint in the plumage of the sedge warbler. The feathers of the back and wings are streaked with darker brown in their centres, so that the whole colour scheme is stronger than that of the reed warbler, but at the same time no less protective. Where the latter bird depends for camouflage on the drabness of its colours, the sedge warbler relies on the differences of light and dark, which g ve a striped effect that blends wonderfully with the variegated tones of the reeds and sedges. As in so many of the birds already described, there is a pale stripe over the eye, surmounted by a further stripe, in this case almost black, and this feature is so marked in the sedge warbler that one can distinguish it from the reed warbler at a glance. Moreover, the sedge warbler is a smaller bird, being under five inches in length, as opposed to the five and a quarter inches of the reed warbler.

The sedge warbler's nest is not such a work of art as that of its cousin, being usually supported rather than suspended, shallower than the reed warbler's, made of grass and moss, and lined with down and hair. It is usually near the water, among the bushes or the lank vegetation of the riverside. The eggs are greenish or buff, with spots, and covered with blotches of darker brown; occasionally a few of the hair-lines that are more characteristic of the buntings are present. They usually number five or six and are laid in the latter half of May.

Both the birds just described are summer visitors, but the third of our reed birds, the reed bunting, is a resident in many parts of the country, although it may also be classed as a summer and winter visitor.

FAR more noticeable than either of the warblers, the reed bunting is also larger, but it shares with them the love of the waterside. The cock is a handsome fellow, for his head, chin and throat are black, and round the back of his neck he has a snow-white collar, joined by a stripe that runs up to the base of his bill on either side. The underparts are white, with a brownish tinge and streaks of that colour towards the flanks, while the upper parts are brown with dark centres to the feathers, giving the same streaked effect as we have already noticed in the sedge warbler. The hen bird has none of the striking plumage of the male, for her head is reddish-brown, with a stripe of brown on either side of the chin, and a buff eye-stripe. The rest of the underparts are buff, often streaked with brown, and the upper parts are similar to those of the male.

In an earlier chapter (page 320) some description of the finches has already been given, and the buntings, of which the present subject is our first representative, are members of the same family. They are generally rather larger, more stoutly built birds, and the reed bunting is no exception. It has, however, the same typical finch beak, short and strong and conical, admirably adapted for a diet of seeds. The buntings are not as a rule such good songsters as the finches, and this is true of the reed bunting. Although it sings, in many seasons, from February until the autumn, practice never seems to make it perfect. Its song consists of a few irregular, unmusical notes, trailing off weakly into nothing. Its more characteristic note is the call note, *seep*, *seep*, which is one of the sounds of the reed beds that becomes after a while as familiar as the very rustle of the plants.

During the summer months the reed bunting feeds on insects, its especial prey being large flies, such as the daddy-long-legs, and the caterpillars of the moths that live in the vegetation of the river meadows. In winter its very serviceable beak is employed in the quest for seeds, and the reed bunting mingles with other similar birds to form the large flocks that haunt the farmyards and fields when food is scarce.

M. H. Crawford

VARIEGATED EGGS

The markings—a mixture of spots, blotches, and curious scribbled lines—on the eggs of the reed bunting are typical of the group to which the little bird belongs. The nest, neatly made of meadow grasses with a lining of fine hair, is placed on or near the ground.

The large, rounded nest is built early in the year, and is situated on the ground, or in a clump of cut osiers, or among a mass of rushes. Reeds, grass, flags or moss are usually employed in its construction, and the lining is often of the feathery reed flowers or of hair. The eggs are brownish, with markings that vary from purplish-brown to black, as well as many spots only a little darker than the ground colour. They number from four to six, but the second and third broods, which are often found, may contain only three in a clutch.

O. G. Pike

BEAU BUNTING

This colourful cock reed bunting is the Adonis of the waterside, for neither his own spouse, nor his reed and sedge warbler neighbours, are possessed of plumage that can compare in any way with his, in which rich browns are crowned with a black head and snow-white collar.

Several rare warblers that are very closely related to those described at the beginning of this chapter are recorded from time to time in the British Isles, and one of these, the marsh warbler, breeds in a number of localities in England, especially in the west. This bird resembles the reed warbler in appearance, but in colour it is rather lighter, has a more greenish tinge to its brown back, and is yellower beneath; the legs, too, are paler. The song, however, provides a more certain means of distinguishing between the two birds. Described as resembling the song of the reed warbler, but having the execution of the blackcap, its notes have a musical quality that the reed warbler's lack, and the bird mimics other birds as it sings. The fact that the song is often uttered at night, when most other birds are quiet, enables us to locate the bird if we are lucky enough to live in a district where it breeds.

Few birds spend such a short time in the country as does this little migrant, for it arrives usually in June and leaves in August. The nest, which is slung by two handle-like loops from the stems of marsh plants, also provides a means of assuring us when we have discovered this rarity, and the eggs are lighter than those of the reed warbler, with bolder blotches and streaks. They are illustrated in the colour plate facing page 165 (Fig. 14).

CEDARS THAT FLOURISH IN BRITAIN'S PARKS

INTRODUCED into Britain in the palmy days of the seventeenth century, when the country squires were appreciating afresh the joys and beauties of country life after the storms and exile of the Civil War, the cedar of Lebanon is still to be found in many a park. It is described and pictured in the chapter that follows, together with its cousin the deodar, introduced from India just over a century ago

THE cedar of Lebanon is perhaps best known as the tree used by the Biblical kings in the building of their temples, but, though not a native of the British Isles, it is one of the finest of all our trees, and one which now grows freely in many parts of the country. Introduced in the second half of the seventeenth century, it rapidly became popular as an ornamental tree, and the majority of the specimens that were planted at that time and have been planted since are still alive, for this is a tree that lives to a ripe old age. The massive grandeur of the trunk, the wide, flat spread of the branches, the rich green of the leaves, are features that we are bound to notice, whether we regard trees from the point of view of the aesthete, the naturalist, or the timber merchant. When it does not grow to a great height, moreover, the cedar of Lebanon makes up for this lack by the solidity and thickness of its trunk and the immense spread of its great boughs.

KNOWN almost equally well as the deodar, the Indian cedar differs considerably from the cedar of Lebanon, although by many botanists the two are thought to be merely sub-species. Its branches are much shorter and the general shape of the tree is pyramidal rather than square-topped, while the tips of the branches are more delicate and often hang downwards. These apparently slight differences in detail amount to a considerable difference in appearance, and the deodar is a graceful tree for all its size, and has none of the majestic solidity of the cedar of Lebanon.

In both these trees the leaves are in the form of typical "needles," such as are found in all the conifers. In the cedar of Lebanon they are about an inch long and in the deodar they are slightly longer. These leaves are borne, as in the larch, in clusters, which are arranged spirally round the stem, and often supported on short stalks. They are persistent for three or more years, and are of a characteristic glaucous or sea-green hue. In the deodar the stalks on which the leaf-clusters are borne are shorter than in the cedar of Lebanon.

THE male flowers are borne in catkins, which are short, but produce an enormous amount of pollen for their size. In colour the catkins are reddish-yellow, and they appear at the ends of special shoots, whose growth is arrested because of the catkins. The female flowers, which appear in shorter catkins at the sides of these shortened shoots, give rise eventually to short, fat, solid cones, in which the scales appear to be lenticular in shape, their long axis running round the cone. These cones are flat-topped and are easily recognizable, their difference from those found in the other members of the coniferous group being very marked. They are slightly over four inches long, and often more than two inches in diameter; those of the Indian cedar are rather smaller.

The cones of both the cedars take two or three years to ripen, and even then remain on the tree for another couple of years or more. They are at first a pleasant, greyish-green colour, often with a pinkish tinge, but this gradually becomes a fine, deep, purple-brown. The

CONE CLUSTERS

The cones of the cedar of Lebanon, and of the deodar, its Indian relative, do not hang down as do those of the Scots pine, but stick upright, like round and fat night-lights. They are supported on short stems from the sides of the thick, leafy branches, which often grow so close as to form an impenetrable mass.

W. F. Taylor

seeds which are borne in the cones are irregularly shaped, and have a long wing as in the Scots pine.

Apart from their shape, it is the trunks of these two trees that best show their chief points of difference. In the case of the cedar of Lebanon the bole is short, the lowest branches often being only four or five feet above the ground, while many of the finest specimens possess no central main trunk at all. From the one great bole, which may be as much as 25 feet in circumference, branches shoot outwards and upwards in all directions, so that the tree is like a living green fountain in which innumerable sprays seem to spring from one single mouthpiece. The lower of these branches bend, when they are some distance above the ground, and run in an almost horizontal plane. Others, higher up, turn out less, and those at the very top run almost straight upwards, so that the whole tree has a remarkable appearance of solidity.

From the Himalayas to Britain

THE deodar has already been described as a typically pyramidal tree. It has a single main trunk which runs straight upwards to as great a height as 150 feet, although specimens so fine as this are not often seen outside the Indian Himalayas, where the tree is a native. The girth of such a tree as this may be as great as 30 feet, and the whole tree has a grandeur and beauty of form that must be seen to be appreciated. The characteristic solidity of the cedar of Lebanon, however, is quite absent, for all the branches grow out from this one main trunk, almost horizontally, and droop downwards at their extremities, so that the outer parts of the tree seem to sweep the ground, leaving within a cool cavern of green shade. A very interesting feature of the deodar is its ability to

DEODAR DETAILS

Below are shown, in a single picture, all the important details of the deodar's make-up. The mature cone, product of the young cone fertilized by pollen from the male flowers, stands upright from the branch. The leaves, or "needles," of typical conifer form, are borne in large bunches on short stalks.

H. Bastin

British Museum (Natural History)

EXOTIC CONIFER

It needs only a glance to tell us that this is no common British tree, so alien seems its shape. It is, in fact, the deodar, also known as the Indian cedar. This tree was introduced in the 19th century, and is still less frequently found outside parks or gardens than is the cedar of Lebanon.

produce new branches low down on the bole, when the original ones have been cut off.

Further slight differences may be observed in the bark of these trees, which in both cases is rough and deeply fissured, being rather coarser in the case of the cedar of Lebanon than in the deodar. On the upper branches the bark flakes off, and that on the outermost twigs is often almost completely smooth.

As timber trees both the cedar of Lebanon and the Indian cedar are extremely valuable, their timber being, in fact, regarded by many as almost imperishable. There are records of deodar beams that had been in use for

E. J. Hosking

MASSIVE FRAME

The massive bole of the cedar of Lebanon bears huge branches near its base, as can be seen in the above photograph. This is a feature more to be expected in such trees as the oak and beech than in a conifer, and it adds character to a tree that is generally regarded as one of the finest in the world.

considerably more than 200 years being employed in the building of a new house, when the one of which they were originally part had been demolished; and in India there are many ancient wooden bridges whose deodar piers have withstood several centuries of submersion without showing any signs of decay.

When the deodar was introduced into Britain in 1831, many young trees were raised from seed, their rapid growth delighting their owners. The Government, encouraged by the apparent success of private experiments, thereupon imported enormous numbers of the seeds and distributed them to landowners, in the hope that they would enable them to make up for the tragic shortage of oak-wood resulting from widespread felling to meet the needs of the Napoleonic wars. Unfortunately, it was found that, although the deodars grew to a satisfactory size, their timber was in no way comparable with that of the tree when grown in its native surroundings. For this our variable climate and different soils were to be blamed; the trees were neither so long-lived nor—and this to the timber merchants is even more important—of such uniform and regular size and quality as the foreign trees.

The fact that certain trees which in foreign countries produce fine timber yield a poorer quality in Britain is noted elsewhere in the case of two other conifers, the larch and the Scots pine, and is one of the many disadvantages for which our changeable climate is to blame. A further point is that in its native land the deodar grows at a far greater height above sea level than would be possible here, being found at its best between six and ten thousand feet above the sea, and growing well even up to 12,000 feet above sea level.

The wood of the cedar of Lebanon has the same admirable qualities as that of the deodar. It is close-grained, and of even consistency, does not split and is durable, besides having the characteristic smell to which it owes its real popularity. Boxes, furniture and, above all, the wooden envelopes of lead pencils are made from cedar, although nowadays other wood is often substituted in the case of the last-named.

It is in the Bible that cedar is chiefly referred to as a timber, and the cedars of Lebanon were for long regarded as a symbol of all that is durable and grand. Of the numerous references that are made to this tree in the various books of the Old Testament, we may choose the following from Ezekiel (xxxi, 3-6): "Behold the Assyrian was a cedar in Lebanon with a shadowing shroud of a high stature: and his top was among thick boughs.

H. Bastin

MARKS OF MUTILATION

The bole of this deodar shows signs of having had a number of its small branches amputated. In contrast to the cedar of Lebanon, the deodar commonly bears a large number of small branches low down, and it can, at times, regenerate them where they have been removed—a feature most unusual in a conifer.

The waters made him great: the deep set him up on high with her rivers running round about his plants and sent out her little rivers unto all the trees of the field; therefore his height was exalted above all the trees of the field, and his boughs were multiplied; and his branches became long because of the multitude of the waters when he shot forth. All the fowls of heaven made their nests in his boughs, and under his branches did all the beasts of the field bring forth their young, and under his shadow dwelt all the great nations."

BROAD-BRANCHED CEDAR

In many a private park a magnificent cedar of Lebanon stands in erect stateliness as a worthy monument to the taste of some bygone squire. After centuries of sturdy growth these importations from a foreign clime preserve in our age of bustle and change something of the well-ordered and unhurried spaciousness of the olden time

REED WARBLERS AT HOME

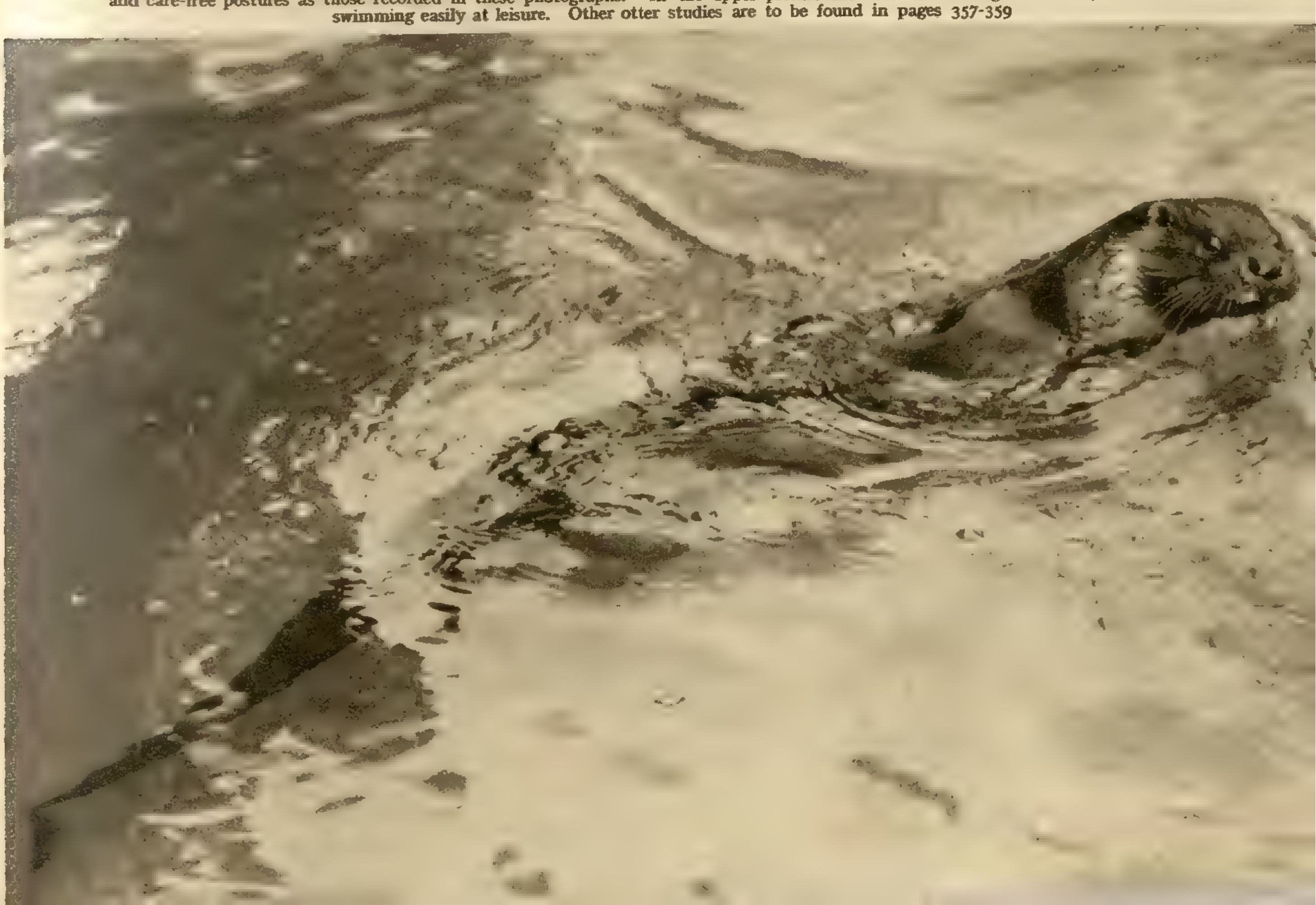
In places where reed beds abound the reed warblers have their homes—neat little nests of grasses and sedge woven round a number of the slender stems. Emerging just above the nest-edge may be seen the beaks of the chicks

O. G. Pike

A. E. Thompson

OTTER AQUATICS

Generally speaking, the otter is a nocturnal animal and only very occasionally can specimens be observed in daylight in such unaffected and care-free postures as those recorded in these photographs. In the upper picture the otter is treading the water, while below it is swimming easily at leisure. Other otter studies are to be found in pages 357-359



DOWNLAND FLOWERS

This photograph was taken just where the South Down slope begins to rise from the flat and cultivated Weald. The most conspicuous of the plants that are seen in the foreground is the great mullein; others include henbane, viper's bugloss and nodding thistle *E. J. Bedford*

GEMS OF COLOUR 'MID THE DOWNLAND GRASS

FOR mile upon mile undulates the ancient turf of the downs, nibbled close by countless generations of roaming sheep. During the summer months the verdurous carpet is starred with brightly-coloured flowers of varying shape and size, while in the more sheltered dips and hollows, in the ditches and in the ruts that mark the downland tracks, other and larger flowers appear. Thus is presented a characteristic flora, some of whose principal members are described below

ALTHOUGH they are for the most part low-growing, on account of the shortness of the turf and the thinness of the soil, the flowers of the chalk downs are among the most attractive that the rambler is likely to meet, and the majority of them are so markedly regular in their appearance that they are easily found and recognized. From early spring to late autumn the pale grasses of the chalk hills are starred with innumerable tiny flowers, which compel our attention, not so much because of their individual beauty, but rather by sheer force of numbers; they cling, in fact, to every patch of the dry downland soil that can support them.

Amongst the grasses of the downs, and especially where the soil is dry and poor, one little flower attracts notice by the number of its starry, whitish flowers rather than by their individual beauty. For all its small size, the eyebright, as it is called, is a stout, almost shrubby little plant; indeed, in well-watered upland meadows it grows to a height of about a foot, being so different in general form that one might almost take it for a separate species. The flowers, too, are of two sizes, found on separate plants, and they also vary greatly in individual plants. In the larger flowers the stigmas ripen before the anthers, but in the smaller the reverse is the case.

The eyebright is a member of the great natural order, *Scrophulariaceae*, the chief characteristics of which are described in Chapter 8 (page 255). In common with most members of the family, it has a tubular corolla that is divided into two lips, the lower one of which is three-lobed. In this flower both the lips are white, with purple stripes running inwards, while there is a yellow patch on the central lobe of the lower lip.

Eyebright was Good for Eyesight

IT is partly this bright colour scheme that draws our attention to this little plant, and to this feature it probably owed its name originally, being used in medieval times as an eye medicine. In herbals of later days the plant also appeared as an eye specific, the suggestion of cure in the name lasting till modern times.

With strongly serrated edges, and longish, ovate form, the leaves of the eyebright are in strong contrast to the flowers, for they are very dark green and grow on opposite sides of the stem. The stems, too, are often coloured reddish or brown and are wiry and stiff. The plant is, like many members of the order, a partial parasite on other plants.

Another small flower—one that is noticeable by reason of its colour and delicacy—is the milkwort. This is also found on heaths and commons everywhere, but it is on the chalk that it grows at its best. Typically blue, the flowers may be any colour from deep purplish to red, pale lilac or even pure white, and the plant, too, varies greatly in size and robustness according to the conditions under which it grows. The organs which, from their appearance, we would take to be the petals, are, in fact, the sepals; the petals are very small and are more or less combined with the stamen-filaments. The sepals, really five in number, appear to be only two, and these are coloured; they are lanceolate in shape. It is only when we examine the flower closely that we find that the other three sepals are present, tiny green bodies in the normal position, at the top of the flower stalk. The leaves of the milkwort are also lanceolate, tough, and bright green, and grow on alternate sides of the stem. This flower takes its name from the fact that it was thought to increase the yield of cows which ate it: in actual fact, it is probable that the pastures in which the milkwort flourished were those which, in any case, gave the best food for cattle.

The perfoliate yellow-wort is an upstanding plant, though an exposed site and poor soil may prevent it from

EYEBRIGHT FOR SORE EYES

Popular in former days on account of its supposed virtue in the treatment of some ophthalmic diseases, the eyebright thus earned a name which might equally well be derived from its attractive appearance. Notice the stiff, upright stems, dark leaves, and two-lipped flowers of this pretty plant.

R. B. Matson

A. B. Dennis

OF MANY COLOURS

The flowers of the milkwort (above) vary enormously in colour, ranging from white to all shades of red or blue. As may be seen from the enlarged photograph on the right, the sepals are more conspicuous than the petals, which combine with the stamen-filaments to form a little coxcomb.

attaining its proper height. The flowers are bright yellow, with eight sepals and petals, the petals being arranged in the form known as rotate, that is, the whole flower is rather wheel-shaped, the petals running out from the centre at an angle, and not directly. The yellow flowers account for one part of this plant's name, the leaves for the other, those on either side of the stem being joined together so that the stem runs through the middle of what seems to be a single leaf ; this form of foliation is sometimes called connate.

From its form, with the wide spreading corolla and long, tubular calyx, we might assume that the yellow-wort is a relative of the gentians ; and it is, indeed, a member of the *Gentianaceae*. Another member of this order to be found on the chalk downs is the centaury, a plant the foliage and stems of which, like those of the yellow-wort, have a greenish-grey appearance. In the case of the centaury, however, the flowers are bright pink, and their diameter is less than half an inch ; those of the yellow-wort may be twice as large.

Centaury is another small plant that attracts us by the way in which it stands upright and displays stoutly-branching stems, tough, opposite leaves and umbels of pink flowers. Unlike the yellow-wort, its flowers have their parts arranged in fives, a feature which is more or less typical of the gentian family.

The roundish, bright yellow flowers of the rock rose and its thin, creeping stems with their long, opposite leaves are soon familiar to the wanderer on the downs from June to September. The sepals are of two kinds : three of them are of normal size, and are pinkish in colour, veined with green, while the other two are very small and are green. The petals, five in number, are extremely soft and delicate, notched on their outer edges. The leaves of the rock rose are soft and hairy, and their under-surfaces are covered with a fine down. This is not a very conspicuous feature, however, and in this respect the rock rose is in no way comparable to our next subject, the great mullein (*see* illustration in photogravure, page 374). This is an absolutely unmistakable plant, for it grows to a height of perhaps six feet, and is in flower for a long period.

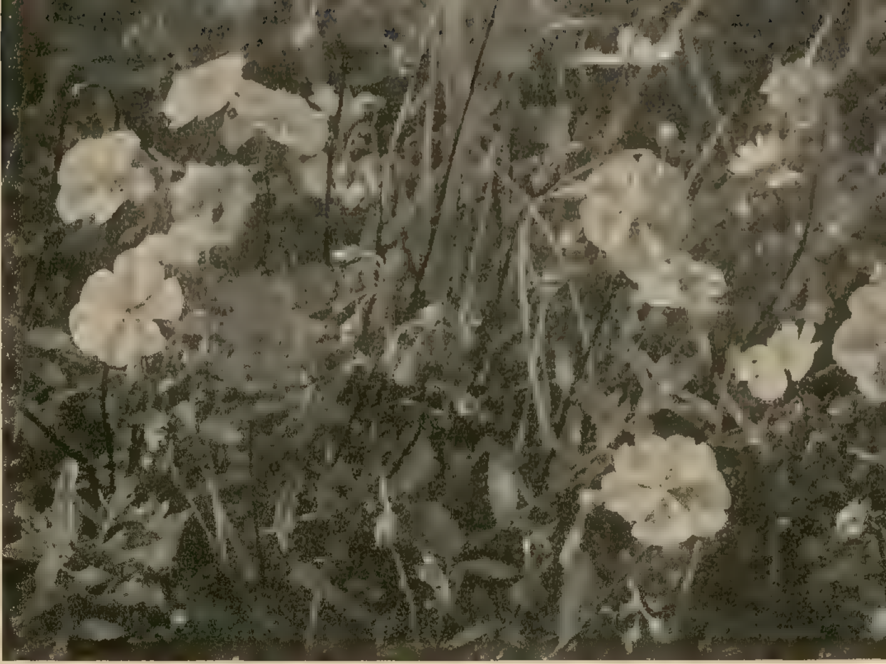
GENTIAN RELATIVES

In the photographs below are shown (left) the yellow-wort and (right), the centaury, both members of the gentian family. Their relationship can be seen in the upright growth and form of branching of both plants, but the former has yellow flowers, while those of the smaller plant are pink.

Hinkins

Both stem and leaves are covered with a coat of thick, shaggy hairs, which give the whole plant a curious greyish appearance, as if its original greenery had been powdered over with flour.

The mullein's rosettes of pale grey-green leaves, which have earned it the name "flannel leaf," are a conspicuous feature of the downland for many months, but it is not until May that they send up the long spikes of their flowers. These flowers, of which a great many are borne in a solid mass for perhaps two feet up the stem, do not open in any regular order, so that we may see a tall grey rod with patches of yellow at intervals all the way up its height. The radical leaves enlarge ultimately till they may be as much as fifteen inches in length, and there are other leaves up the whole stem. The stem leaves are sessile, and are prolonged down the stem, which is therefore winged in a curious and distinctive manner. In the upper part of the stem we find flowers in the leaf axils, and the spike itself is as green with small leaves as it is with the flower buds.



A. W. Dennis

ROSE OF THE ROCKS

The bright yellow flowers of the rock rose (the garden *Cistus*) are among the commonest on the chalk downs. Their petals are peculiarly delicate and weak, and the flower is not one that should be picked, for it soon dies if removed from its parent plant.

One other species of mullein, the black or dark mullein, is common in some parts of the downs. It is easily distinguished from the great mullein by its less matted hairs and altogether slimmer growth; its smaller height, only about three feet; and its more open flower spike, in which the bright yellow flowers are made more conspicuous by the purple hairs which cover their stamens. In both these plants the flowers are apt to be very irregular, a fact which helps to show that they are representatives of the order *Scrophulariaceae*, although very different from many of its other members.

The flower spike of the pyramid orchis species is alone sufficient to identify it. The flowers are of the reddish-purple colour that is found in many orchids, though perhaps a trifle redder than usual, and are rather small; but they are so closely packed together on the flower spike that the plant is easily found, especially when it is growing contrastingly among the dull yellowed grasses of the dry chalk pastures. A pleasant feature of the flowers of the pyramid orchis is the spur, which is extremely long and slender, and these flowers also differ from most orchids in being slightly scented.

The stem of this plant is much more slender than that of most members of the family, and it may grow to a height of eighteen inches. In both these particulars it forms an exact contrast to the dwarf orchis, whose stem is no more than six inches in height and is very broad, stunted and juicy. This plant has small flowers, just over ¼ inch in diameter, with the upper petals and the sepals dark purple and green, and the lip-petal, which is broad, spotted, deeply lobed and white in colour. The flowers are borne in a very dense spike, and the leaves are unspotted, rather broad and sharply pointed.

This species flowers in May, but one cannot hope to find the pyramid orchis until the summer. The dwarf orchis is not so common as the other, although it is found locally all over England. Several other species of orchids are found locally on the chalk downs of the south midlands and south coast counties, such as the great brown-winged orchis and the monkey and the military orchis. They are described briefly in a later chapter.

DOWNLAND ORCHIDS

The smaller of the two adjoining pictures shows the flower spike of the pyramid orchis, a common member of the orchids found on the downs. In the larger picture we see several plants of the dwarf orchis, less common than its pyramidal cousin, but, for all its small size, no less attractive.

H. Bastin

SNAILS OF OUR FIELDS AND GARDENS

THERE are many kinds of snail in Britain, as will be discovered by a perusal of the following chapter. The best-known is the species that leaves a slimy trail on our garden paths and fences, but another highly interesting species is the edible. These are fully described below, and some mention is made also of some of the other members of the snail family

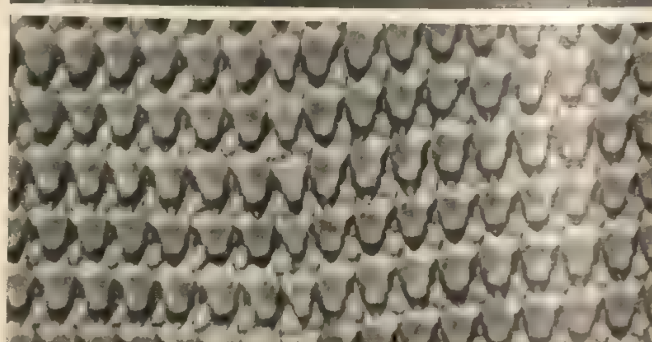
NATURALISTS have included in the Mollusca all those animals that have unsegmented bodies; some of these protect themselves by means of an outer shell or exo-skeleton, composed of calcified material. The Mollusca are divided into three sections, the *Gastropoda* (from Greek," stomach foot "), snails, slugs, whelks; the *Siphonopoda* (" tube foot "), cuttlefish and squids; and the *Pelecypoda* (" axe foot "), or *Lamellibranchiata*, which includes the mussels, the oysters and the clams. In the present chapter we deal with the common, land-living gastropods which are known to all who keep a garden and to the majority of folk who have spent any time in the country. Among these may be mentioned the common garden snail (*Helix aspersa*), which is very widely distributed over the entire globe, and is undoubtedly one of the most highly developed of our European gastropods. It can accommodate itself to almost any climate, and has been met with as high as 4,000 feet above sea level in just as great abundance as it is found at the equator. With the exception of the edible snail, *Helix pomatia*, which was commonly eaten in parts of England not so very long ago, the garden snail is the largest of British land-living gastropods. Usually black or grey in colour, it may vary very considerably in its markings according to season, locality and the quality of available food. Even yellow or pink individuals have been discovered by some naturalists, while others claim to have seen specimens with a distinctive green tinge on their shells.

THE edible snail, on the other hand, has a pale yellow and sometimes almost white shell, with three or four indistinct brown bands. The whole of the shell of this snail is covered with a brown epidermis, which is very liable to be rubbed off if the snail is handled. The lines of growth, which run at right angles to the whorls, are very much coarser than in the garden snail

SNAILS AT SUPPER

These two garden snails (*Helix aspersa*) are rapidly devouring a large rhubarb leaf on which they have found themselves after climbing up the thick stalk. The markings and general shape of the shell of the garden snail can be clearly seen in the photograph.

J. J. Ward



J. J. Ward

TENTACLES AND TEETH

Top photo: on its head the snail is provided with two pairs of feelers or tentacles; the upper pair carry on their ends the knobs in which the eyes are situated, while the lower pair are used solely as organs of touch. In the lower photo are seen some of the snail's 15,000 teeth, borne on its "lingual ribbon." (× 5 and 125 respectively.)

John Kearton

LAYING HER EGGS

Having just deposited two neat little eggs, this edible snail (*Helix pomatia*) proceeds to leave them where they have fallen on the ground. The edible snail may be distinguished from the common garden snail chiefly by its considerably larger size, but also by the coarser lining on the outside of the shell.

The head—situated, curiously enough, at one end of the foot—is also protruded from the shell while the snail is moving. This part of the body bears two pairs of tentacles, the upper pair of which are long and provided on the end with knobs, on which the eyes are situated. The lower pair are about a quarter the length of those above them and have been proved to be used entirely as organs of touch.

The mouth is situated just between the head and the bottom of the foot, and consists of a small hole lined on the inside with a sharp, knife-like series of teeth composed of a horny substance. This well-equipped mouth is capable of gnawing through even the toughest of cabbage leaves, and, unlike many vegetable-destroying insects, the garden snail is able to eat not only the portions between the ribs of the leaves, but the actual ribs themselves.

If removed from its shell, a snail is seen to consist of a long series of tapering organs beautifully adapted to fit into the portable house which the animal carries on its back. Lining this dwelling there is the flap of muscular and skin-like tissue mentioned above as the "mantle." This may easily be seen in a live snail just fringing the edge of the shell when the foot is fully extended.

The shell of a snail is composed of three distinct layers. On the outside there is the uncalcified layer or *periostracum*, which, unlike the hard outer surface of an insect, is not composed of chitin but of a somewhat different substance called *conchiolin*, which resembles silk in its composition. The next is the *prismatic layer*, which is the first layer of the shell proper and is made up of the crystals of almost pure calcium salts set side by side as minute prisms perpendicular to the surface of the shell. The last internal or *nacreous layer* is also made of calcium salts, but the crystals are laid down in a somewhat different manner, for instead of being side by side they are arranged in sheets. The edges of these sheets "crop out" all over the surface and form minute irregularities which cause light "interference," thus producing in some shells the beautiful iridescence which has given the nacreous layer its name of "mother-of-pearl."

The growth of a snail naturally necessitates an increase in the size of the shell, and this is carried out by an organ called the "mantle," which adds to the periostracum and prismatic layers on the outside edges and to the nacreous layer all over the inside of the shell.

The upper surface of the snail's shell is raised and twisted into what is known as the *visceral hump*, because it contains all the viscera, or internal organs of the body. This hump or "spire" in the garden snail may have from four to five whorls, while in the edible species the spire nearly always consists of five.

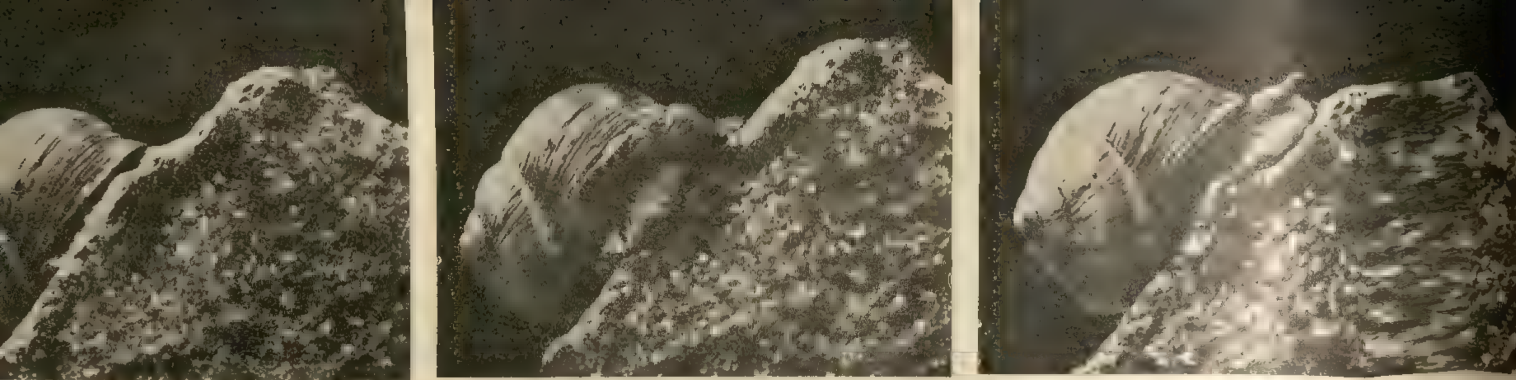
THE greater part of the body of all gastropods is contained within the spiral of the shell. The large part of the snail which can be seen when the animal is propelling itself along, is known to naturalists as the "foot," and is composed to a great extent of specially adapted muscle. Movement itself is effected by a series of rapid muscular waves passing along the foot from front to back, and adhesion to the surface on which the snail crawls is guaranteed by the secretion of large quantities of mucus, which, when dried, constitute the familiar trail known as a "snail's track."

IN the living specimen, too, just below the shell on the right side, a tiny opening may be discovered; this is the respiratory aperture through which the animal carries out the process of breathing. Inside the mantle—in fact, between this organ and the rest of the body—there is a comparatively large cavity richly lined with blood vessels, through which the de-oxygenated blood is pumped by means of the heart.

The remainder of the snail's anatomy is also of particular interest to the naturalist, as, indeed, is the whole animal, which wonderfully exemplifies the way in

SNAIL VARIETIES

Above are illustrated, about actual size, some of the smaller snails found in Britain. 1. Helix lamellata; 2. H. aculeata; 3, 4. H. pulchella; 5. H. rupestris; 6. H. lupicida; 7, 8. H. rotundata; 9. H. cantiana; 10. H. revelata; 11. H. obvoluta; 12. H. rufescens; 13. H. fusca; 14. H. pisana; 15. H. carthusiana; 16. H. sericea; 17. H. hispida; 18. H. arbustorum.



J. J. Ward

WITH SLOW BUT STEADY STEP AND SURE

The movement of the snail is carried out by a series of contractions of the muscles of the "foot," on top of which it carries its shell, containing the organs of both reproduction and digestion. The garden snail, seen in these photographs, after awaking from its afternoon sleep, starts to sally forth in the evening on an expedition in search of food. Very slowly it raises its portable house and contracts its muscular and mucus-covered foot, holding it in place on the slanting surface of the rock on which it has been sleeping.

which the process of evolution can adapt a living organism to extraordinary conditions. Not only are the entire digestive organs and digestive glands enclosed in the small space within the shell, but also all the reproductive organs, both male and female—for like the earthworm, the snails are hermaphrodite. In many species each individual plays the part of only one sex at a time, the other sex organs lying dormant during the process.

THE process of snail courtship is, perhaps, one of the most extraordinary in the whole panorama of animal selection. The reproductive organs include an especially devised muscular apparatus which is largely concerned with courtship, and which is said to be capable of manufacturing minute calcareous darts about 1-20th of an inch in length. These are shot through the air at the extended foot of the snail which is acting as the female, in order to excite it. One very interesting point concerns the sex part played by each individual snail, namely, what it is that decides whether a snail will act as male or as female during the process of mating. As is usually the case with the determination of sex in hermaphrodite creatures, it has been found that feeding plays a large part in the decision of the snail, and that those snails which were fed particularly well acted as females while those less amply supplied with food played the part of males. This is probably due to the fact that while the male is only required to produce a microscopic germ cell, the female must not only supply the egg cell, but must also provide the usual quantity of pre-natal nourishment which goes with it, sometimes called the yolk.

The process of mating is carried out by copulation, snails being provided with the full complement of primary sexual organs analagous to those in the mammals.

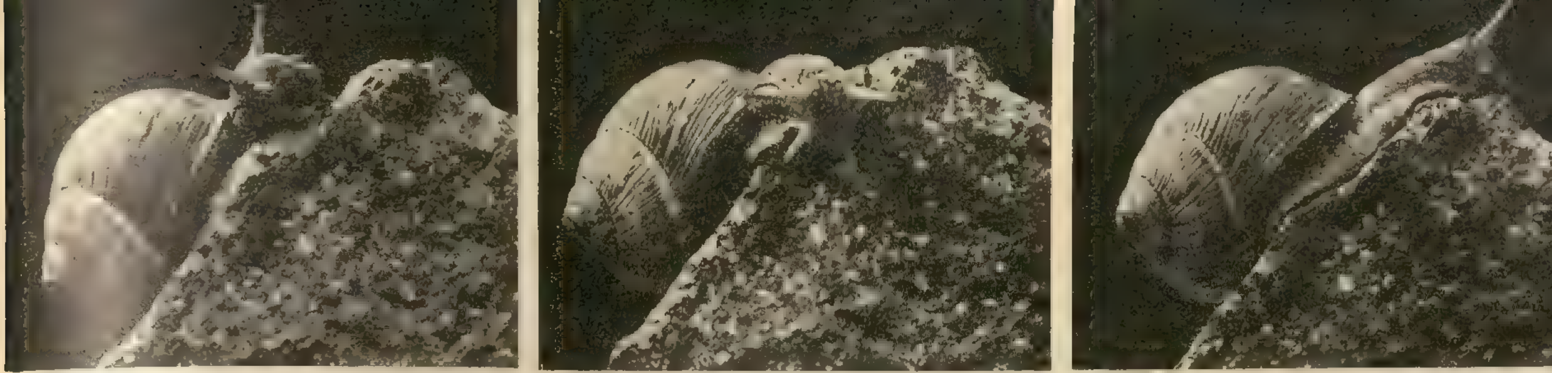
Soon after mating, which in nearly all species takes place in the spring, the snails which have taken the part of females lay their eggs. These are oval or round, and are covered with a tough, white membrane which protects them from the damp and from the attacks of insects and bacteria. Snails usually lay their eggs in tiny holes dug in the damp ground near the roots of shrubs and trees, and they sometimes, though by no means always, cover them with a thin layer of earth. The little white balls which are the eggs of snails may often be found in April and May lying neglected on the ground. They adhere by means of a sticky mucus, and after about twenty to thirty days of development the young snails hatch out. The babies are usually different in colour from their parents and bear a glossy, unbanded shell of about one and a half whorls. They subsist upon much the same food as their parents and grow throughout the summer until the coming of winter, when they hibernate. The growth of the shell can be very rapid indeed, as much as 60 millimetres being sometimes added in the course of a single month.

Snails will eat practically anything that is green, and frequent any cultivated land where they can find shelter either in a hedgerow or on the wall of some dwelling. They are very fond of old walls thickly covered with ivy, and on these they may be found during the colder days of winter huddled together in clumps of as many as a hundred if the situation is particularly suitable. They have very distinct homing instincts, and if a lettuce patch, for example, is situated even quite

J. J. Ward

SLIMY CONTRIVANCE

These pictures of *Helix nemoralis* demonstrate the way in which the snail utilizes its mucus to overcome the protective spikes on a rose stem. Covering the thorns with slime it glides over them unharmed, and when resting (right) hangs by mucus threads attached to the shell. The small top picture shows a "dart" (× 22) used in the courtship of certain snails.



J. J. Ward

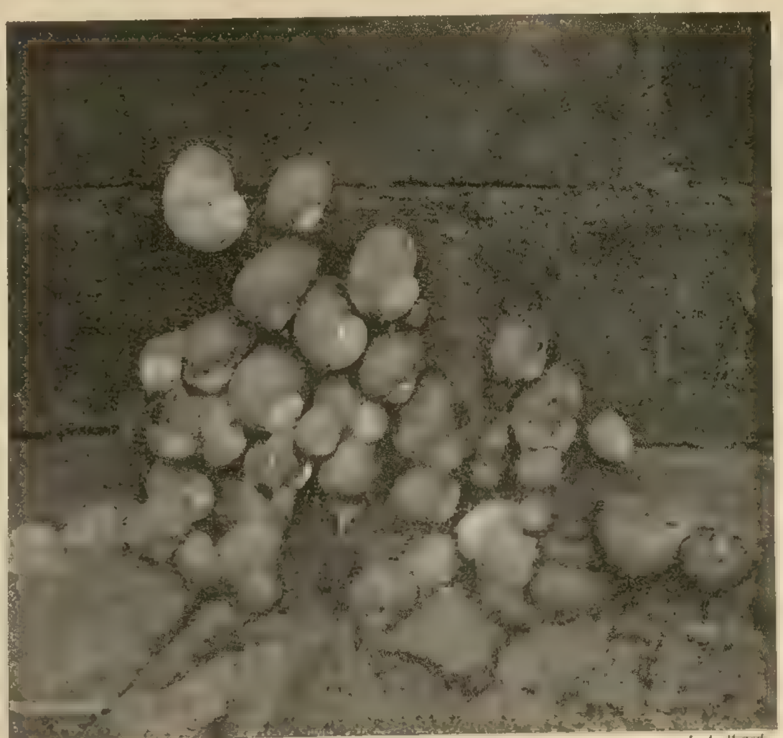
THE SNAIL PROCEEDS UPON ITS WAY

Continuing the story from the opposite page, the rock must first be thoroughly investigated, and a whole series of observations are taken with both the feeling-tentacles and the eye-tentacles. Having satisfied itself that there is no food to be had, and that there is no immediate danger from any of its natural enemies, the snail starts to climb over the summit of the rock. Stretching out its foot and extending its head, it slowly glides forward, the mucus on the under-surface acting as a lubricant.

a long way from their usual resting-place they will not, as might perhaps be expected, seek a new home near the source of food but will travel backwards and forwards every day.

Snails are somewhat sensitive to cold and hibernate through the entire winter. Congregating in large numbers, they bury themselves as far under the ground as possible in order to keep out the cold, and they also close the mouth of the shell with a thin membrane known as the epiphragm in their efforts to keep warm. Sometimes during a very cold winter snail-shells may be found containing dead snails that have been frozen to death with as many as nine or ten epiphragms strung across the mouth of the shell. Scientists have recorded that snails supplied with proper food can withstand a temperature as low as 18 degrees of frost.

As regards the exploring activities of snails, a naturalist once traced the tracks of a snail in springtime up the branches of a hazel tree situated in a hedgerow to a bird's nest built in a fork of the branches. The snail paid nightly visits to the nest until, one night, finding the mother bird away, the little animal crawled over the edge of the nest and attacked the eggs with its sharp teeth ; after having forced its way through the shell, it then proceeded to suck the contents. This was, of course, a particularly dangerous way in which to seek its food, for the bird was a thrush—the deadly enemy of snails—and, had the mother returned while the snail was still on the egg, there would have been quick retribution.



J. J. Ward

WINTER RETREAT

Just below the surface of the soil at the foot of a brick wall is a favourite hibernating place for the snail, and in this picture a number, both young and old, can be seen clustered together out of the way of the birds and the frost. A few turns of the gardener's spade have revealed them in their hiding place.

In the British Isles there are 81 different species of land-living gastropods, ranging in size from the edible snail (sometimes two inches in length) to the tiny *Vertigo*, the shell of which is no larger than the head of a pin. Twenty-one of these species, including both the edible and the common garden snails, belong to the genus *Helix*. The hedge or striped snail (*H. nemoralis*) is much smaller than the garden snail and is usually red or yellow, ornamented with from one to five dark bands. The rim of the shell in this species is dark brown, but in the closely allied uncommon garden snail (*H. hortensis*) it is almost invariably white. Both *H. nemoralis* and *H. hortensis* exhibit great variations in banding. The Kentish snail (*H. cantiana*) is smaller than *H. hortensis* and is tinged with red, while the hairy snail (*H. hispida*) is darker in colour, being almost black in some varieties. This species is found under layers of moss and dead bracken, and gets its name from the minute, hair-like bristles covering its shell. *H. arbustorum* is a species about the same size as *H. nemoralis*, but has a somewhat different coloration, being brown and mottled with yellow.

On the South Downs the snail collector will certainly find the tiny South Downs snail (*H. virgata*). It is usually white with a dark brown band, though some specimens recorded have been black with yellow bands. At some seasons of the year there are so many of this and the allied *H. caperata* on the Downs that the sheep eat them as they crop the grass—a diet to which has been attributed the fine flavour of South Down mutton.

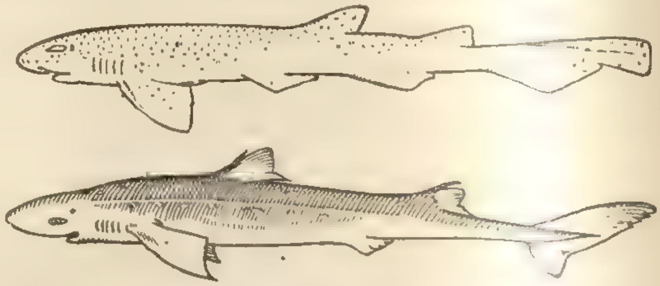
DISTINCTIVE DIFFERENCES OF THE DOGFISH TRIBE

ONE of our commonest seafish, the dogfish possesses some characteristic features that make it of particular interest to the naturalist and scientist—features which are referred to in the study that appears below. The greater part of the chapter, however, is devoted to a description of the principal species of dogfish—the greater and lesser spotted dogfish and the black-mouthed dogfish—that are encountered in our home waters

ONE of the commonest of the elasmobranchs, or cartilaginous fishes, found in British waters—indeed, one of the commonest of all our fishes—the dogfish is heartily hated by both line- and sea-fishermen for its habit of taking bait intended for better prey, and destroying fish already entrapped in the net. To the scientist it is, however, of great service, for it is used in the majority of courses of comparative anatomy to illustrate many of the characteristics of fish in general, and of elasmobranchs in particular. For this reason the dogfish merits a detailed description. Let us consider it first as a typical example of the elasmobranchs.

As can be seen from the diagram on the right, the dogfish, though it possesses the typical piscine form, is marked by certain obvious differences which distinguish it from the bony fishes or teleosts. The shape and position of its mouth constitute a peculiarly elasmobranch character; it is wide and crescent-shaped, and is situated ventrally. This is the reason why elasmobranchs, such as the sharks and dogfish, have to turn sideways before biting their prey. Again, the dogfish possesses no *operculum*, or gill covering; the gill openings are long slits, five in number, while in front of them and situated just behind the eye is a pre-branchial opening known as the spiracle, which is present only in the elasmobranchs, being vestigial in the embryo of bony fishes.

Characteristic also is the dogfish tail. There are three different types of fish tails, known as protocercal, hetero-



DOGFISH AND SHARK

Of these two drawings the upper shows a nursehound or greater spotted dogfish, while the lower represents a picked or spiny dogfish, which is really a form of shark. Note the different shape of the tails and the spines in front of the dorsal fins of the picked dogfish.

cercal and homocercal (Gr. *protos*, first; *heteros*, different; *homos*, like; and *kerkos*, tail). The great majority of fish possess a homocercal tail, or one in which the caudal fin is evenly developed in the dorsal and ventral lobes. A few degenerate or primitive forms have a crude and ribbon-like caudal fin surrounding the tail, and this

KNOWN BY ITS SPOTS

The greater spotted dogfish is so called both on account of its relatively large size and also because of the larger spots which mark its body. In the photograph below the external gill openings are well shown in front of and above the pectoral fin.

W. S. Berridge

Schensky

ANSWERING THE CALL OF INSTINCT

The remarkable photograph reproduced above shows two greater spotted dogfish in the process of mating. Dogfish, like the sharks, skates, rays and a few of the bony fish, secure impregnation of the ova internally. To this end the male elasmobranchs have a portion of the pelvic fin modified as a clasper or intromittent organ. Below, the camera records a dogfish actuated by another primitive urge—hunger. Essentially predatory in habit, its general shape is well designed for the pursuit of prey, and it will be seen with what easy gait it moves through the water, smelling rather than seeing its way, for salt water is so dense as seriously to impede vision.

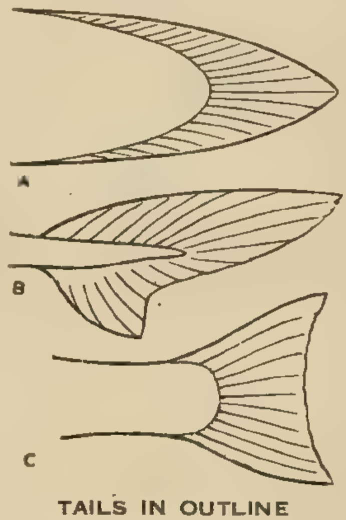
N. Kingston

N. Kingston

PROFUSELY SPOTTED

The lesser spotted dogfish is both the commonest and the smallest of this group of fishes. It differs from its larger cousins mainly in size and in bearing more numerous spots. The other two fish in this photograph are a monk fish (left) and (half beneath the dogfish) a thorn-back ray.

form is known as protocercal. The heterocercal tails are those in which the caudal fin is unevenly developed, being much bigger on the top fin; this form of tail is characteristic of elasmobranchs, and is found also in the sturgeon, a fish which is one of the last survivors of an ancient and nearly extinct piscine race. A glance at the diagram below will show what an efficient propelling organ this type of tail is, and how it accounts, in some degree, for the speed which these fish can attain.



TAILS IN OUTLINE

These diagrams illustrate the three principal types of tail found among fishes: A, protocercal; B, heterocercal; C, homocercal.

THE pelvic fins of the dogfish are another notable feature; in the male they have a fold modified to form a clasper, or copulatory organ, by means of which the sperm is carried into the cloaca of the female, and thence to the oviduct, thus ensuring internal fertilization of the ovum. These claspers are found in the males of all the elasmobranchs, including the skates and rays; only a few of the bony fishes, which are viviparous, also secure internal impregnation, and in these cases it is always a different organ that is modified for the purpose. A further remarkable point about the dogfish is the extreme roughness of its skin, which will rasp painfully against a hand passed over its back from tail to head. This is due to the form of the scales, each scale being a small piece of bone embedded in the skin, and is the only evidence of bone present in these elasmobranchs. These placoid (Gr. *plax*, plate) scales are entirely different from the cycloid (Gr. *kyklos*, circle) scales of the bony fishes, which have a comparatively large circumference, and overlap, forming a complete but flexible covering. The placoid scales of the dogfish are of extreme interest to the zoologist, since in the early stages both scales and teeth are undifferentiated, and they would seem to have a common origin. The scales are also occasionally modified to form spines, as is seen in the allied fish, the sting rays and the spinous sharks.

How to Distinguish the Dogfish

IT has been shown how the dogfish, as an elasmobranch, differs from the teleosts, or bony fishes; it now remains to be seen how it differs from its nearer relatives. The dogfish can be distinguished from the sharks by its comparative smallness, the common dogfish attaining a length of about two feet, though one of the larger forms may measure as much as five feet from head to tail. Apart from this it should be noted that the dogfish and the skates are the only members of the elasmobranchs that lay eggs, their eggs being contained in horny cases, which are laid in the autumn. These cases have long tendrils attached to them with which the female dogfish secures them to some stone or piece of seaweed. The development of the embryo within the egg-case continues during the winter, and the baby dogfish hatches out as a complete fish in the spring. Unlike many other fish, it has no yolk-sac to support it during the early days of its existence, and must forage for itself as soon as it is born. This perfection of development of the elasmobranchs gives them a favourable start in the struggle for existence and compensates for the relatively fewer eggs that are laid in comparison to the teleosts.

There are four fish found near our coasts which go by the name of dogfish: the lesser and the greater spotted dogfish, the black-mouthed and the spiny or picked dogfish. The last two can be dismissed in a few words—the black-mouthed dogfish, because it is a rare visitor to our seas,

being an inhabitant of the Mediterranean and warmer waters; and the spiny dogfish, because it is not really a dogfish at all, and is called by that name only through popular misconception.

Of the other two varieties the lesser spotted dogfish is by far the commoner, occurring in large numbers round our coasts, and feeding on the smaller fish. It comes inshore in the autumn for spawning; the egg-cases are laid two at a time, each equipped with long tendrils which attach them to seaweed or some other stationary object, and mature through the winter, the young hatching out in the following spring. The greater spotted dogfish is from two to two and a half times the size of the smaller; its spots are also much larger. Apart from these differences the fish are similar in appearance. The greater spotted dogfish is, however, rare in comparison with its smaller cousin, though it is common enough to be well known to fishermen, who in many localities have given it the name of the "nursehound."

Martin Duncan

DOGFISH IN NAME ONLY

Despite its name, the spiny dogfish is not really a dogfish but a member of the shark family described in pages 438 to 440. It is illustrated here, however, as it is often caught in the same area as the greater spotted dogfish, and is somewhat similar to it in size and shape. Only one of its two spines is visible in the photo.

S. Berridge

AT CLOSE QUARTERS

The crescent-shaped mouth of the dogfish is situated beneath the head, thus making it necessary for the fish to turn sideways before biting its prey. The evil-looking appearance of the dogfish is obvious in this photograph.

Dogfish are skinned when caught, but their flesh, which is marketed under the name of fluke, is coarse and of inferior quality. There are two other great disadvantages to the catching of dogfish: first, they have sharp teeth and can bite severely; and, secondly, like most omnivorous fish, they are frequently afflicted with internal parasites, mainly of the types of worm known as ascarids, which have a most revolting appearance. Since the dogfish leads a predatory life, it is forced to be active in search of its prey, which, however, it cannot pursue by sight for any great distance, owing to the denseness of sea-water which limits the range of vision; it is for this reason that small fishes are capable of swift, darting speed over a short course, tactics which help to keep them secure from marauding foes. As an aid to the capture of their prey the elasmobranchs have developed very fully that part of their brain and nervous system which relates to the sense of smell, namely, the olfactory tubes, and the dogfish are credited with the ability to smell for long distances under water. Thus they are able to swim to any dead organism in their vicinity and so to act as scavengers of the sea.

SEA FISHING FOR AMATEURS

Those who wish to fish at the sea for the first time should not burden themselves with equipment. Until sea fishing has actually been tried and the novice has decided to continue with this fascinating sport, buying equipment is a waste of time and money; local fishermen who let out the boats can usually supply the necessary gear, but care should be taken to insist that a rod be supplied, as a fish caught on a hand-line will not provide nearly as good sport as one caught with a rod.

Once it has been decided to fish in earnest, the amateur should then proceed to the selection of a rod, of which there are three main types in use for the more ordinary sea fishing: (1) a stiff two-piece rod about seven or eight feet in length and made of greenheart or hickory; (2) a second rod of about the same length, but with a more pliable top; (3) a rod, also pliable, but having a length of 10 feet.

The first rod is the type best suited for bottom fishing, since its strength is adapted to the more heavy tackle that is necessarily used in this type of fishing. The second rod with the pliable top is the best type for catching pollack, cod-fish, and mackerel, which are sporting fish with good fighting qualities. The longer rod with the pliable top is most suitable for bass, which is usually considered the finest fighting fish in British salt waters. Rods are commonly made of cane, split cane, greenheart, hickory, or steel. Of these materials, split cane is the best, as it is strong, pliable and light in weight.

One rod that may be used for general purposes can be bought, but it is certainly preferable to have at least two rods, one that may be used for bottom fishing and another that is kept for sporting fish. A third rod, such as that designed for bass, is useful but not necessary.

The rod should be chosen carefully. Fishing apparatus may be bought at quite a small cost, but it is always advisable to buy the rods and the reels from a good maker. Cheap rods may warp or break and cause great disappointment, but a good rod, treated with reasonable care, will last for many years.

ROTUND MONSTERS OF THE ROOT-FIELDS

MOST urban visitors to the countryside are puzzled when, in the course of their rambles, they meet a field bearing a crop of what the farmer calls "roots." Are they turnips, swedes, or mangel-wurzels? the "hiker" asks—and usually has to turn away with his inquiry unanswered. Below, the characteristic features of each of the three roots are fully set forth, so permitting of their easy recognition

WHEN walking through an agricultural district we often see huge fields carrying crops which to the townsman's inexperienced eye consist either of turnips or of plants that look something like turnips; but whether they are turnips or some other "root" he would find it very difficult to say. Collectively such crops are known to the farmer and the country-dweller as "roots."

To the stock-breeder, at least, "roots" constitute one of the most important of crops. Sowing a root crop, a farmer will say, is the best way of getting land into condition; and besides, roots are indispensable for feeding cattle throughout the winter months. Before the introduction of root crops into this country by Viscount Townshend in 1724, most of the cattle were slaughtered with the coming of the autumn frosts, as there was no means of feeding them in winter except on dried fodder, and in cold winters cattle were unable to subsist entirely upon hay. Just a few beasts were saved by great effort to serve as parents for the next year's stock. The introduction of roots which contain all the essentials found in summer greenstuffs, revolutionized the position, however, for roots can easily be stored over a long period.

SWEDES ON SHOW

To the farmer who goes in for stock-rearing "roots" are a most important crop. The farmer and his labourer are here seen investigating a field of swedes, which, judging from the "pulled" specimens, seem to have done very well.

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A field of roots looks very like a giant's back garden stocked with enormous radishes. In the home counties, the eastern counties and in the south of England especially, a country lane may run for miles across land bordered on either side by well-groomed fields of mangel-wurzels, swedes and turnips. In the north of England large areas under root cultivation are not so common, though there also the farmers make good use of the knowledge that they can feed their cattle easily and effectively in the winter by growing this type of crop. Since, however, roots are particularly sensitive to frost, they are usually spring-planted and have hardly time to grow to their full size before they have to be gathered on account of the approach of the autumn frosts.

As suggested above, one of the first questions which the rambler will ask on seeing a field of roots will be: "Are they mangel-wurzels, swedes or turnips?" The best way to distinguish between these three popular root crops is by the shape of the roots and the colour of the flesh. The turnip has a spheroid root with white flesh; the swede, which is a more complex variety of the turnip, is more elongated and has flesh tinged with yellow; while the mangel-wurzel, a more distant cousin of the turnip than the swede, is rather more cylindrical, and has flesh of a deep orange colour.

Swedes and Turnips Differentiated

BUT while the colour of the flesh of a root varies with the species, the tints which appear on the outside skins are today practically useless as a means of identification, owing to modern cross-breeding, which has given rise to several different varieties and sub-varieties of roots, many of which are identical in coloration, though different in species. Botanically, the swede-turnips, as the scientist calls them, differ from the true turnip in several ways, the most obvious of which is the appearance of the leaves, which are somewhat darker than grass-green in colour and, in the mature plant, much smoother than those of the true turnip. Around the "neck" of the swede root, also, appear numerous leaf-scars, which are absent in the turnip proper.

Of all the root crops, apart from the recently introduced sugar-beet, the mangel-wurzel, or mangold, is the most valuable, although not quite so widely grown as the other two owing to its sensitivity to climate. At the end of the summer, when it has reached its full size, the root has usually four or more large leaves of a dark green colour, which in a well-cultivated field give an even effect very similar to that of a field of young corn,

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ARRAY OF TURNIPS

The clear, smooth skin of the turnip and the almost spherical shape are well illustrated in this photograph. The flesh of the turnip is white as compared with the yellow and orange flesh of swede and mangel-wurzel respectively.

though the colour is far deeper in tone. The rambler, on passing such a field, will see that the mangel-wurzel root is of an orange, sometimes a crimson colour, tinted here and there with splashes of green and brown, and, unlike the turnip and the swede, it is usually grown half-way out of the soil.

Varieties of the Mangel-wurzel

In Britain there are five chief varieties of mangel-wurzel grown by the farmers, and numerous sub-varieties have recently been introduced and are being tried out. The names of the recognized types are descriptive of their general appearance and shape, those which are most usually grown being known as the *long*, the *ox-horned*, the *gatepost*, the *tankard* and the *globe*.

The nutritive properties of the mangel-wurzel are somewhat higher than those of the swede and the turnip, which are its rivals as forms of cattle food. The actual starchy material in a root is known as the "dry matter," and as this is of great value in the fattening of cattle, the fact that the mangel-wurzel has 12 per cent dry matter against 4 per cent in swedes or turnips is proof of its superiority. Cane sugar, too, is an important food factor, and the presence of this constituent varies greatly in quantity with the different varieties. In the long variety, particularly in a sub-variety known as the *long red*, the quantity of cane sugar is somewhat low, being reckoned at from 3 to 4 per cent, while in the tankard and the globe 7 to 8 per cent is an average yield. Another advantage of mangel-wurzels is that the farmer can "pull" (or harvest) and stack them without waiting for them to dry, no harm resulting from their being damp and so liable to become warm in the stack.

Cultivation of roots is carried out in various ways, but a standard has been set by the experimental farm at Rothamsted, in Hertfordshire, where the Government Agricultural Research Station is in being. Roots may be grown continuously on the same piece of ground for several years, with the aid of artificial manures, but more usually they are included in a system of rotation. In March the ground is stirred with a chain harrow, consisting of a chain mat with a number of spikes on its underside. This is dragged over the field by a pair of horses or by a tractor, thus loosening the surface and exposing the underparts to the air. Throughout March and April deeper stirring is continued, and it is now that the manures are added. The next step is the ridging of the ground with a special plough, and after this the soil must lie undisturbed for another three weeks before the planting of the seed, or drilling, is begun.

Roots are always pulled six months after sowing, so that there is never any chance for the plants to develop to their full height or to go to seed. The farmers obtain their seeds from firms that cultivate the plants for the express purpose of raising the seeds, which are drilled-in one year, the crop being collected at the end of the second year of growth. Strong, leafy stems grow up from the roots and may reach a height of as much as three feet. During the summer of the second year these branch out and bear numerous small yellow flowers clustered together. After the fertilization of the flowers

HARVESTING THE MANGOLDS

These large mangel-wurzels, or mangolds, have been "pulled" and placed ready for carting to the stack, there to remain until the winter. Usually the largest of the root crops, the mangel-wurzel may grow to the size of a football, and, being very hardy, is the most popular of cattle foods.

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ROOTS FOR COMPARISON

Three of the principal roots placed in juxtaposition for comparison. The turnip (centre) is the nearest to the original species (*Brassica campestris*), from which the swede (right) has been bred. The mangel-wurzel (left) belongs to the beet family, Chenopodiaceae.

the fruits come into being, and these are collected and put on the market as seeds.

After purchasing his supply of seed and preparing his ground, the farmer drills the seed into it with an ordinary drilling machine in the same way as wheat is planted, two horses or a tractor pulling the machine backwards and 'orwards across the field. In the southern counties the seed is usually sown after the third week in April, though farther north it is often necessary to wait until the first week in May, to ensure that the seeds are not attacked by frost.

In about a month the seeds generally show above ground as tiny green plants clustered together in groups. A number of plants spring from each seed, and for this reason more land has to be prepared than is actually drilled, the young plants being separated and transplanted over a larger area. As soon as they are all transplanted hoeing is begun, either by hand or with a horse hoe which runs between the lines, uprooting any weeds and generally loosening the soil around the young roots. This process cannot be carried out much later than June, for by then the fibrous roots of the young plants have grown so long that they spread out between the rows and there is danger of the hoe damaging them and ruining the crop. After the hoeing is completed a "top dressing" of manure is put down.

The crop grows rapidly throughout the warm summer months and by the end of August the roots have in many cases grown to the size of footballs. They are harvested in October by simply hoeing round them and pulling them up by hand, and then they are carted and stacked in long, low tent-shaped piles.

Turnips and mangel-wurzels are always carted, and sliced by machinery into small portions capable of being easily mixed with the other constituents of cattle food. When swedes are used for fattening sheep or pigs, the animals are penned out among the roots.

Revealers of Nature. 12

WILLIAM COBBETT

If William Cobbett can justly be said to have "revealed" anything, it is certainly William Cobbett himself, but in so doing he revealed also the character of the whole English nation and, to a point, of the whole English countryside. Carlyle correctly summed him up as "the pattern John Bull of his century," and all who knew him remarked on his exact resemblance in feature and in character to the traditional type of the English farmer. A work that contains a section on the Crops of Our Countryside cannot, therefore, overlook the claims of Cobbett to be a revealer of Nature. His roots deep in the soil—he was the son of a farmer and the grandson of a farm-labourer—he was never, even in the midst of his most dangerous political activities and when in America, without his own plot of land; while his celebrated "Rural Rides" is full of homely agricultural knowledge and scraps of valuable observation concerning the less wild aspects of our countryside. So closely was he identified with agriculture that his name was given to an important crop—that of maize—which was in his day generally called "Cobbett's corn."

William Cobbett was born in 1762 or in 1763, at Farnham in Surrey, and until he was 14 worked on his father's farm. Then he ran away to London and got a job at Kew Gardens, but this did not suit him long, and he began the real adventures of his career by joining the army—by mistake—when about 20.

From an engraving by Bartolozzi

The amazing career of Cobbett does not concern us here; he became the *enfant terrible* of the Press in America and England, and the most powerful journalist of his day.

It was about 1806 that William Cobbett began to emerge as the champion of agriculture; he has been described as almost the sole example of "the articulate peasant," and even at the height of his power as a writer he did not forget the stock from which he sprang. Throughout the hundreds of articles, the scores of pamphlets and the dozens of books that constantly streamed from his pen until his death in 1835, the influence of the English countryside can be seen and felt. Whether it is in "Rural Rides," which contains many vivid and revealing pen-pictures of the land he saw as he pounded along on horseback throughout England, or in his less-known works, the same forceful strength, bred of the farming class, and the same insight into Nature and Man's everlasting struggle with her are apparent

Cobbett's agricultural interests also took practical shape in the farms he owned, at different times, at Botley, Hampshire; in America; in Kensington; at Barn Elm; and at Normandy Farm, near Guildford. The erratic nature of the man was not a quality which might be expected to lead to success in these experiments, and not all of them paid him; but from them Cobbett gained further power for his arguments, and through them "knew what he was talking about" when he attacked the Government's agricultural policy.

DAINTY CAMPIONS FOR SUMMER NOSEGAYS

JUST as the pinks and carnations, sweet-williams and phloxes, are among the most popular of garden flowers, so their wild cousins, the campions, are always culled with delight by the country children and by the town-dwelling visitors to the countryside. Red campion and white, ragged robin, bladder campion, sea campion and moss campion, together with some of the most common catchflies—these are the altogether pleasing subjects of the chapter that follows

AMONG the commonest of the wild flowers that adorn the waysides and hedges in the summer, the campions must soon become as familiar to the naturalist as to the country children, who will pick them in great bunches on their way home from school. Although they are often in bloom quite early in spring, they are essentially flowers of the summer, and there is something in their manner of growth and, in one case at least, in their scent, which is more in tone with the lush vegetation of summer than with the springing greenery of the earlier season.

J. J. Ward

CAMPION GUEST

The caterpillar seen above is that of the lychnis moth, which delights in a diet of campion seeds, and may often be found curled up in comfort inside the fruit.

Two plants bearing the name of campion are especially common in the British Isles, namely, the red campion and the white or evening campion; and two other members of the same genus, *Lychnis*, are also very widely distributed—the ragged robin and the corncockle. The plant known as the bladder campion is a member of a different genus, *Silene*, as also is the sea campion; but all of them belong to the great natural order, *Caryophyllaceae*, two of whose members, the two stitchworts, are described in page 162. The botanical features that distinguish the members of this family may be briefly summed up as follows. The flowers have four or five petals and the same number of sepals, the stamens being twice as numerous. The seed capsule has a single cell. One of the most distinctive features of the order is to be found in the stems, which are almost always markedly jointed, while the leaves are opposite. The flowers are typically white or red, and regular in outline. Among the garden flowers belonging to this group are the pinks, carnations and the sweet-williams.

RED CAMPION, although, like the other campions, a typical summer flower, may be seen in bloom at an extremely early date; in fact, one can find plants showing flowers in every month of the year. The flowers are of a warm reddish-pink, the corolla being tubular, with five petals diverging at the mouth of the tube. Each petal is deeply cut in the same way as in the stitchwort. The calyx forms a tube, divided into five pointed segments. There are two distinct types of the flower, some having the stamens developed, others having only the pistil developed, which shows that this is a dioecious plant, that is, one in which the sexes grow on different individuals. The fruit consists of the ovary, which is developed into a rounded and rather pear-shaped body, the calyx being retained as a close covering for the whole fruit. Inside these fruits we may often find the caterpillars of certain moths which lay their eggs at the base of the fruit; when hatched, the little caterpillar bores

COLOURFUL 'RED ROBIN'

Among the many country names given to plants by children, that of "red robin" for the red campion (shown below) is one of the commonest. The straight, sturdy growth, opposite leaves and deep-cleft petals are typical of the order *Caryophyllaceae* to which the campion belongs.

H. Bastin

its way in, and then feeds on the seeds, passing its life in the security of this adopted home. Growing on opposite sides of the soft and hairy stems, the leaves of the red campion are sessile and, in shape, ovate. The whole plant usually grows to a height of $2\frac{1}{2}$ or 3 feet, so that its flowers are easily visible among the tall hedgeside grasses.

Strongly Scented White Campion

In an even greater degree this feature is found in the white campion, which was at one time considered to be only a sub-species of the red variety, the older botanists knowing the plants as "red and white robins" in contrast to the ragged robin described below. The flowers of the white campion are cut up in the same way as those of its red cousin, and are rather larger, being $1\frac{1}{4}$ inches across, while those of the other plant are usually slightly less than an inch. The calyx is rather longer in the flowers of the white campion, their tips being especially conspicuous. The whole plant is of a lighter green than the red campion, a feature that is often found where one of two closely-related species has red flowers and the other white. The white campion has earned its second name, evening campion, by its scent, which is especially noticeable in the evening. So strong is this scent that where masses of the plant are found clothing the banks of a deep lanè still hot from the day's sun, the effect may be almost overpowering.

RAGGED CHARMER

Ragged robin is the name of this pretty plant, and its origin will be obvious after a little examination. The adjective is accounted for by the way in which the petals are cut up, while "robin" refers to the red-coloured blooms.

E. J. Hosking

H. Bastin

FRAGRANT AT EVENING

The white, or evening, campion gives forth its scent when the heat of the day has passed, and then its smell is even more attractive than its fine flowers. The long, ribbed calyx, distinguished by its breadth and pale colour, is useful in comparing this with the red campion in page 389.

Ragged robin is a most suitable name for the third member of the campion tribe, for its pale pinkish petals are normally cut into four deep segments, two of which are much longer than the other two, so that the flower, which looks rather like a wheel with thin, irregular spokes, might be taken for a badly torn example of a red campion. Of its decorative value there is no question. In its favourite haunts—the wet meadows that lead down to rivers and streams, the rush-strewn areas that are too

M. H. Crawford

TRULY BLADDER-LIKE

When the petals are still present, the bladder campion shows in sufficient measure typical features of its group, but after they have fallen the inflated calyx becomes even more conspicuous. In the right-hand picture above, the styles may be seen projecting from the bladder's mouth.

poor to be worth cutting for hay, or the wet, grassy patches that one finds on the edges of bogs—it is a most welcome sight, a delicate and dainty flower in a place where much of the vegetation tends to become lank and coarse. It flowers from May to August. This is one of the plants that were formerly known as cuckoo-flowers, as its specific Latin name, *flos-cuculi*, still bears witness.

The fourth common species of *Lychnis*, the corncockle, is described more suitably in a later chapter dealing with cornfield plants. There are, however, two rare species that are worthy of passing attention, the red German catchfly and the mountain catchfly, also known as the red Alpine catchfly. For these two plants a name has been borrowed that is more usually reserved for the typical members of the genus *Silene*, just as several members of that genus are called campions. Although they are sticky plants, they are called catchfly rather from their similarity in appearance to the true catchflies than from their qualities as traps for unwary insects. The red German catchfly is found in certain localities among the mountain districts of North Wales and central and southern Scotland, while the other species is confined to a few spots in Lancashire, Cumberland, and the Clova mountains in Forfarshire. The red German catchfly has deepish red flowers, with petals only slightly notched, and clammy stems; the second species is a much smaller plant, with pink flowers only about ½ inch across, and a total height of some 6 inches.

BLADDER campion is so apt a name for another of the common campions that we can be absolutely sure of recognizing the plant. The white flowers have five petals, which are very narrow at the bottom, broadening out into a deeply-cleft lobe. The calyx is broad, pale green and very delicate in appearance, having a number of darker veins running from base to top. It is five-cleft and is puffed out in such a way as to resemble a small, irregularly shaped balloon or bladder. The stems are bluish-green and not at all hairy, being also more slender than those of members of the genus *Lychnis;* the leaves are opposite, the same colour as the stems, which are of the same typically jointed build as has already been mentioned. A typical member of the genus *Silene*, the bladder campion shows the features which differentiate it from *Lychnis*. There are normally only three styles, as opposed to the five of the other genus; the seed

CAMPION BANK

Here a great bank of bladder campions makes a brave show, and attracts our attention to a plant that more often grows singly. The bladder-like calyces do as much to make the plant conspicuous as do the flowers themselves, and can easily be distinguished here.

A. W. Dennis

R. F. Lusser

CLIFF DECORATION

A dry, seaside habitat is all that the sea campion needs, and it will flourish in even the merest crack in the cliffs. When it grows in masses—as is illustrated above—it makes a delightful contrast with the brown rock and the azure of sky and sea.

capsule is three-celled and opens at the top with six valves, instead of five or ten teeth ; the flowers, too, may be either male, female, or bi-sexual.

The second of the campions belonging to this genus is the sea campion, a plant which some botanists maintain to be only a sub-species of the bladder campion, although it is so different that even the beginner should have no difficulty in distinguishing the two. It is a smaller, low-growing plant, with spreading stems close to the surface of the ground ; the petals are less deeply cleft than in the bladder campion, and the calyx is not so much inflated. The leaves are more fleshy, shorter, and not so pointed, while the flowers, which are slightly larger, are not so numerous, only three or four being found together.

A. W. Dennis

RARE FLY-CATCHER

The Nottingham catchfly, shown here, is a beautiful plant, but unfortunately is very restricted in its range. The stems and leaves and flowers all point to its campion relationships.

Next we have the moss campion, found only on the tops of the higher mountains of the British Isles. The plant grows very close to the soil, forming a moss-like carpet of tufted stems. Its short stems are clothed with awl-shaped, hair-fringed leaves, and the flowers are small, pink or white, half an inch in diameter, erect and solitary.

It has already been mentioned that the typical members of the genus *Silene* are the catchflies, three species of which are fairly common. The first of these, known as English catchfly, is the commonest of our catchflies ; it is notable for the sticky nature of its leaves and stems, and the whole plant is rather hairy. It is found especially on gravelly soils and in dry, sandy fields, being often an escape from gardens. The flowers, only [illegible] inch in diameter, are white or pink, and are usually in the axils of the leaves ;

R. M. Adam

MOUNTAIN BLOOMS

Moss campion is confined to hilltops, where it may carpet the ground with its matted leaves and massed blooms. The flowers differ from those of other campions in that the rose-pink petals are not divided. The growth of the plant is most distinctive.

the five petals are slightly cleft. The lower leaves are spatulate, but those on the stem are narrow and lanceolate. The second species that is at all common is the night-flowering catchfly. Distinguished from the last species by its more erect, more branched stems, it comes into flower much later in the year, normally in July, and has larger blooms, as much as ¾ inch across, pale pinkish in colour. The Nottingham catchfly is a rather rarer plant, found locally all over the country on the limestone or chalk soil that it loves. Its fine flowers are about ¾ inch across, and they share with those of the last-named the properties of being fragrant and opening in the evening.

FALLOW DEER OF THE SILVAN SCENE

THREE species of deer are represented in Britain today. The first and wildest of these is the magnificent red deer, described in the first chapter of this series (see page 75). The roe deer, the smallest of the three, is dealt with in a later page. Finally, there is the species which is to be seen in many of our private and public parks—the fallow deer, to whose study the following chapter is devoted

THE fallow deer (*Cervus dama*), which is found chiefly in the parklands and forests of the south, is the most English of our deer, but in spite of its long association with the leafy deer parks and stately mansions of England, there is much doubt whether it is indigenous to this country. Some authorities believe that it was introduced by the Roman invaders, but to attribute to the Romans the importation of much of our flora and fauna is the common practice among naturalists when in doubt, although it is difficult to see why the Romans should be credited with such actions, for Nature-study was not a characteristic of the legionaries. More likely, perhaps, the fallow was here before the Romans, and although neither Caesar nor the other Roman writers make mention of the deer, this may be either because they never saw them, or, seeing them, thought them unworthy of their notice.

Fossil remains of a species of fallow deer have been found in England, a fact which would seem to support the theory that they are natives ; but there is no evidence to prove any distinct connexion between those ancient deer and the wild fallow of today. One thing, moreover, is certain, and that is that fresh blood has been continually introduced into the herds of the manorial parks—particularly by the medieval nobles, who wished to stock the acres of parkland they had enclosed with deer that would be ornamental and decorative as well as serve the useful purpose of filling the larder.

To this end they introduced from abroad fallow deer with light-coloured coats, spotted with white during the summer, for these were more attractive in appearance than the dark, brownish-black, wild fallow. These graceful deer are portrayed in many pictures and tapestries

ANTLERED BROWSERS

In England today the fallow deer is most commonly found in enclosed parks, and this picture shows a typical herd in early summer. It is composed entirely of males, for the sexes are segregated during the summer months. The bucks' horns are half-formed and covered with velvet.

J. H. Stone

F. W. Bond, A. R. Thompson

DARK AND DAPPLED

There are two distinct types of fallow deer—the smaller, dark brown form, and the larger, spotted variety. The photograph above shows a typical dark buck, while that below is a good example of the spotted kind. The difference extends to the antlers, the spotted bucks usually carrying better heads.

of medieval and Renaissance times, for hunting fallow buck was a favourite peace-time diversion of monarch and nobles; and even outlaws, who lived on the game that they could kill, indulged in the sport.

All the so-called wild fallow are of the dark variety. It is supposed that a dark strain was introduced into England from Sweden by King James I, but there are records to show that this type was common in England at a much earlier date. It is probable that this small dark variety is a northern race of the fallow, and some of them may well be descendants of the wild herds which were probably native to these islands. Certainly all the fallow that are found in a wild state on unenclosed land, are of the small, dark type, and have small horns without wide palmation. A number of these wild fallow exist in the New Forest, and wild herds occur in more parts of Britain than is commonly suspected. Pheasant drives often disturb wild deer that have been living in covert and wood unknown to their human neighbours, and evidence that many of the woodlands of Kent and Surrey harbour wild deer may be found in "slots" or tracks marking the turf of the countryside.

The fallow is smaller and more delicately built than the red deer, a full-grown buck measuring only three feet at the shoulder. The coat may vary in colour from a pale chestnut to a brownish black, but only the lighter varieties show the beautiful dappled white markings on the flanks in summer that was a main reason for their popularity during medieval times. The dentition of the fallow deer is the same as that of the red deer (*see* page 77), with the exception that the canine teeth are absent in both sexes.

ONE of the most noticeable differences between red and fallow deer lies in the formation of the antlers. The former have wide, spreading antlers with a long beam and a number of strong points or tines. In the horns of the fallow, on the other hand, although they have two

RIVALS AT GRIPS

Like other deer, the fallow bucks will fight during the rutting season. Owing to the shape of their palmated horns they seldom damage each other as do those deer possessing sharply-pronged antlers. This picture shows two bucks struggling for mastery.

large tines on each side corresponding to brow and trez of the red deer, the remainder is developed into a broad palm, or shovel, at the ends of which are numerous small points. This palmation of the horn is typical of the fallow deer, which is, indeed, the only British species which normally shows it. Occasionally red deer that have been kept in parks and fed through the winter show a hypertrophic horn development similar to palmation, but there is little likelihood of such an antler being mistaken for that of a fallow deer, even by a novice. Similarly, some of the wild fallow that have had to fend for themselves and have fed poorly show little or no tendency towards palmation, but, even so, they do not approximate to the red deer form.

The times when the horns are formed and shed, and the stage of the animal's development when they appear are different in the fallow and the red deer. The old horns are shed slightly later by the fallow than those of the red deer, and the young fallow deer show no sign of horn development until their second year. The horns become progressively larger each year, until the mature antler development is reached in the buck's fifth year. Thereafter the palm may widen and small points may be added, but the horn remains substantially unaltered.

Mixed herds of fallow congregate just before the rutting season, which extends over the last quarter of September and the first half of October. During this time the large bucks collect as many does together as they can, and drive off their smaller and more timid rivals. The males and females remain together throughout the winter and part company only in the spring, when the herd breaks up into small parties of bucks and does.

Fallow fawns are dropped in May or June, and, though usually only one is born, twins are not uncommon and triplets are occasionally found. The fawn is capable of walking, trotting, and obeying its mother's commands when it is only a few hours old; such precocity is typical of animals that have no safe retreat, and must live by the sharpness of their wits and instincts. These fallow fawns are beautiful little creatures, and it is well worth taking trouble to look for one in May or June in Richmond Park or other big deer parks that are open to the public. The exquisitely dappled coat, soft, gentle eyes and long ears cocked inquiringly forward combine to make an appealing picture of innocence. But care must be taken not to approach too close or to frighten these young deer in any way, for they are not always secure on their long, weak legs, and may fall and injure themselves.

The peculiar attractiveness of fallow fawns has often tempted people to tame them and keep them as pets. Such domestication of deer is never a success, for when it loses its fear of men a deer frequently becomes dangerous. There have been many instances of tame deer attacking their owners and having to be destroyed. These attacks often begin as a sort of playful game; but it is a game in which the deer is made dangerous by its very size, and later the animal becomes more vindictive. It is extremely unwise to return "tame" deer to the park, for they are always liable to attack people walking through the grounds.

Distribution of the Fallow Deer

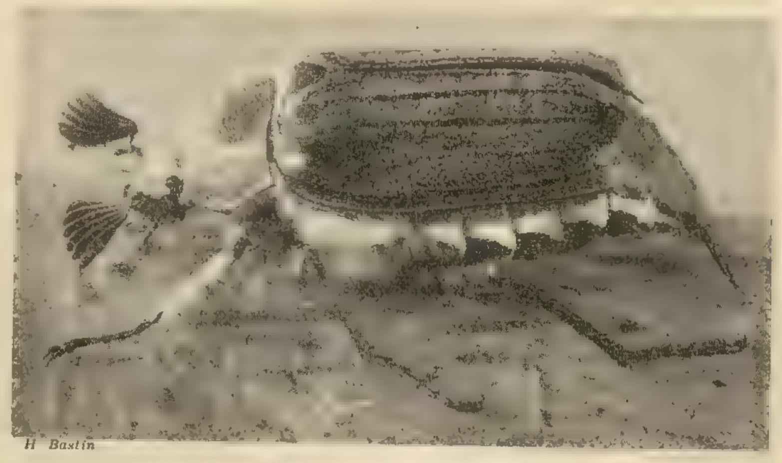
Fallow deer extend northwards into the southern part of Scotland, where they are found both in parks and in the wild state; they are not, however, native to Ireland, and though herds exist there, they comprise the descendants of animals that have been introduced within the last hundred years. It is probable that the fallow deer will remain in Britain for many years yet. Even if most of the other wild mammals become extinct with the extension of the towns and the gradual disappearance of really wild country, the fallow deer will still be found browsing contentedly in the parks, one of the rare examples of an animal that can remain near to men, depend upon men for its protection, and yet avoid being turned into a domestic animal.

BEETLES THAT WREAK HAVOC IN THE GARDEN

DESPITE its reputation as a garden pest, the May-bug, or cockchafer, makes an attractive study for the keen naturalist, and the same may be said, too, of other members of the chafer tribe—the June-bug, for instance, the rose chafer, and the bee chafer. These are all described in the chapter below, and the details of the cockchafer, typical of its kind, are made manifest in the accompanying photographs

ABOUT the middle or end of May, according to whether the season is early or late, we may notice in the gardens and leafy lanes a number of large, brown beetles, which are as much at home on the wing as when crawling among the bushes or foliage. Indeed, it is often through an encounter with one of them in flight that we first meet the common cockchafer. In some years these beetles are so plentiful that they cannot be ignored; on warm evenings the air seems to swarm with them, and they may be seen in hundreds humming and buzzing round the trees and bushes of the garden.

The cockchafer, or May-bug, is one of our most interesting insects, as well as one of the most destructive. It is markedly subject to those periodic increases which are described at some length in the section on Our Butterflies and Moths, page 315; the period of greatest frequency varies, but it is often at intervals of five or seven years that these insects become so numerous as to be a genuine nuisance. The reason for these increases is hard to discover, for they do not occur in the same way as those of the clouded yellow butterflies, namely, by migration, since swarms may arise quite independently in various parts of the world. The cause seems more probably to be looked for in the conditions of weather and climate, combined with the life history of the chafer.



COCKCHAFER IN REPOSE

Known to entomologists as the cockchafer and to the gardener by the unpleasant-sounding name of May-bug, the insect pictured above is one of the worst enemies of the horticulturist. Note the long "tail," which is, however, a harmless appendage, not a sting (× about $2\frac{1}{2}$).

This insect differs from many others in having a long life of about four years, almost the whole of which is spent in the larval stage. This life history has been worked out for many years now, for the cockchafer is such a menace to farmers in all countries in which it is found that as much as possible must be known about it. The adult female, which is active during the late spring, lays eggs in holes which she has dug in the soft soil of fields or gardens or woods. These eggs hatch out after a few weeks and the grubs at once begin to feed on the soft and tender roots of neighbouring grasses or other plants.

The older and larger the larvae grow, the larger the roots they are able to attack and the deeper they tend to burrow, devouring roots, especially of grasses, wherever they go. In winter they dig down deep enough to avoid the frosts, although it is known that they can resist very considerable cold even if they are exposed; their enemy is not frost, but the hungry bird. It is an interesting fact in this connexion that the idea that a severe winter helps the farmer by destroying insects is wholly erroneous; actually it helps the insects, because it makes the ground so hard that birds are unable to dig them out from their winter retreats. The chief enemy of the cockchafer grubs is the mole, which relies on such creatures as one of the staple items of its diet, and in districts where the cockchafer is a pest moles should be encouraged.

AFTER nearly three years the larva is full-grown. It is now a whitish grub, having a fat, succulent body, so curved that the very large hind part is bent forward almost to meet the forepart. The general shape is sack-like, and at the tip of the abdomen there is a stiff spike, which helps to keep the insect in place in its burrow. The head is brown and is armed with very powerful jaws, and has a plate on the top which acts as a shield during the burrowing operations. The six legs are also adapted to help the insect in its subterranean life. Those of the fore pair are broadened out to act as shovels, while the other two pairs have stout spines to assist in obtaining a good purchase on the soil during digging operations.

This grub changes into a pupa early in the third year, and by August the adult insect is hatched. It remains, however, in the snug pupal chamber until the following spring when it burrows up through the soil and takes to the air. Although the life of the adult insect is short, seldom lasting more than a few weeks, in a year when cockchafers occur in swarms they may do an enormous amount of damage, for they are extraordinarily voracious, and spend almost their entire time feeding on the foliage of trees, the oak and the elm especially.

Examination of the cockchafer will show us several very remarkable features. The insect belongs to the

GRUB STAGES

The cockchafer grub lives beneath the soil for about three years, devouring the roots of grass and other crops. The left-hand picture above shows it in characteristic feeding attitude; that in the middle gives some idea of the size of the full-grown grub; the right-hand picture shows the grub burrowing prior to the change from larva into pupa. These pictures are all reduced to about three-quarters natural size. If the shape of the cockchafer grub is compared with that of the lunar dung beetle grubs shown in pages 95 and 96, a marked family likeness will be readily observed.

same sub-order as do the dung beetles described in pages 94-96, and the antennae are of the same type. In the cockchafer, however, they are very much more developed, there being seven fan-like plates. The female has only six of these plates, and they are not so well developed as the male's, a fact which may be compared with the condition in such moths as the oak-eggar (Our Butterflies and Moths, page 187), where the antennae of the male are far the more highly developed. The reason for the development of the antennae is probably the same in both insects—namely, to help the males in finding the females during the breeding season.

In appearance the cockchafer is an absolutely unmistakable insect. The wing-covers are chestnut brown, covered with greyish down, the underside being cloaked with a number of silvery hairs; the thorax and head are greyish-black, and the antennae and legs are brown. At the rear end of the body, in the female, may be seen a short spike, which is the ovipositor or egg-laying organ.

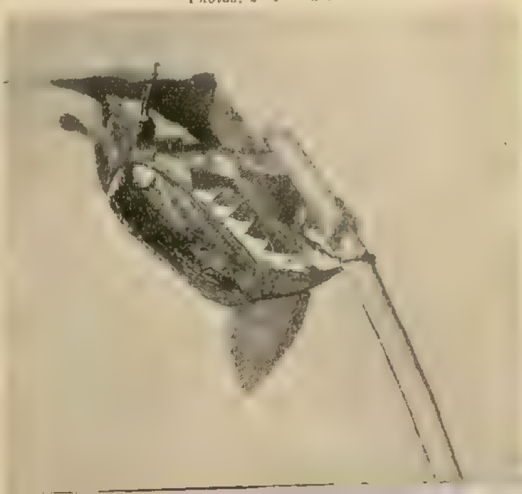
THE cockchafer is only one of a number of insects all of which are of similar habits, and all of which may at one time or another give rise to a "plague." These include members of the genus *Rhizotrogus*, of which the commonest, known as the summer chafer, looks at first sight very much like a small cockchafer; the wing cases, however, are yellowish in colour, softish and almost transparent, and the insect appears rather later than the cockchafer. Its larvae live on the roots of oak trees, whose leaves the adults devour greedily.

Then there is the June-bug, a member of the genus *Phyllopertha*, which is often a real pest in gardens during

CHAFERS IN ACTION

These three pictures show the cockchafer pursuing its work of destruction on the leaves of plants. Viewed from above (left), in profile (centre) and in the act of taking flight (right), it shows itself to be an insect of fine form and considerable size. These photographs are approximately natural size.

Photos, J. J. Ward



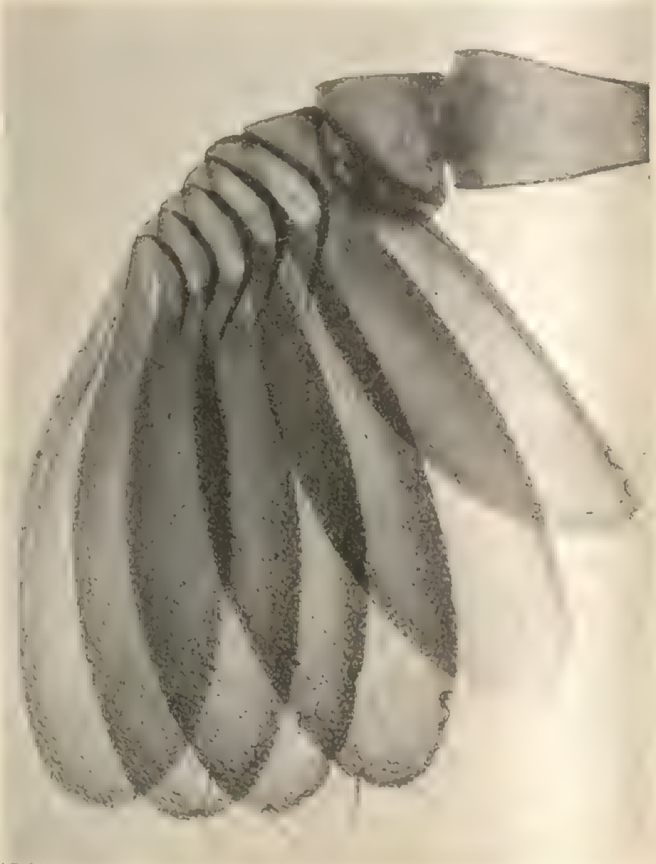
BEAUTY AND THE BEETLE

None but the best is the rose chafer's motto, as the rose-grower discovers to his cost. Penetrating into the very heart of the bloom, and altogether careless of the beauty it is marring, the beetle—itself so brilliantly coloured as to suggest a tropical origin—quickly converts the flower into a disrupted wreck.

the summer months. This is one of several chafers in which the thorax is bright green while the abdomen is brown. They all do damage by eating flowers and leaves, and their grubs live a very similar life to that of the cockchafer already described.

ANOTHER member of this group is the rose beetle, one of the loveliest of all our insects. It is of a brilliant green colour, which glistens with a golden sheen such as is more usually associated with tropical insects. The underside is golden without the green. This insect, which is also known as the rose chafer, may occasionally be found in swarms in the same way as is the cockchafer. The adults are very fond of roses, to which they do enormous damage by eating the petals. Other flowers are also attacked, but the rose is the favourite; and surprise at finding this brilliant insect in the middle of a rose may blind one to the fact that, lovely as it is, it is destroying something even lovelier.

A very similar, though much rarer insect, is that known only by its scientific name of *Gnorimus nobilis*. It is distinguishable by its longer, narrower and more rounded appearance, and by the fact that the legs are green, whereas those of the rose chafer are black. The larvae of both these chafers live on rotten wood, and those of *G. nobilis* are often found as guests in the nests of the wood ant, where they appear to eat the numerous dead twigs. Another insect of the same tribe is the bee chafer,



E. A. Botting

FEMALE FEELER

On their antennae insects have to rely for almost all their knowledge of the outside world, and these feelers are therefore very highly developed. The antenna—female, because it has six plates only—seen in this photograph shows the great development of these organs in the cockchafer (× about 30).

which has the foreparts covered with a thick mat of yellowish hair. The wing-cases are black, crossed by two bands of dull yellow, which unite in the centre. This insect, which is found in the summer on the heads of thistles and similar flowers, earns its name by its remarkable resemblance to a large bee.

HINTS ON BEETLE COLLECTION

In a note in page 96 hints on setting up a collection of beetles were given, together with an account of the best ways in which to kill the "spoil." So numerous are our beetles and so small and insignificant are many of the species, that we now proceed to give some little guidance in the matter of where to look for specimens for the collection.

Moss, especially that which grows in great masses around the roots of large trees such as oaks and beeches, will always yield a certain number of species to the collector. The moss should be removed with great care, and either examined at once, on the spot, or placed without delay in a large tin or other safe receptacle, and then examined when the collector gets home. A note should be made of where the moss was obtained, as the locality may help in the identification of species and is always important when it comes to "writing up" the collection.

Under the bark of dead trees we may find many more beetles, and the bark of newly-felled trees yields a fauna of its own. If we examine a tree shortly after felling, again when the wood is dead, and yet again when the bark has all been removed, we shall find a definite series of beetles that attack the tree trunk in its various stages of decay. The note book is useful here, for by reference to its pages we can tell just what was found when we last visited the tree. There may be a different set of insects each year for three years or so in succession. Not only can the collector add these to his general collection, but, if grouped in their proper sequence and fully annotated, they will make a valuable little study on their own, showing the definite insect succession in the tree under consideration.

SOMBRE ALDERS OF SWAMP AND STREAMSIDE

PRE-EMINENTLY a tree of the marsh, of the banks of lake and river, the alder is widely-distributed in our well-watered lowlands. Often it grows unrecognized, for it has no conspicuous characteristic to attract the roving eye of the rambler. Though inconspicuous, it is not unbeautiful, and below we are told of the features which constitute its charm and by which it may be distinguished

ALTHOUGH it cannot compare with such trees as the elm, the oak and the beech in so far as size is concerned, the alder none the less commands our attention for the beauty which it lends to the scene where it grows. A tree of the riverside and of the summer, it spreads its grateful shade alike over lazy dozers in the punt and the patient angler on his stool; and, moreover, it has a grace and character that distinguish it from all other trees. In both summer and winter it should offer no difficulties of identification even to the inexperienced naturalist.

The leaves of the alder are of the shape known as obcordate; they are heart-shaped, with the point of the heart running down the stalk, so that there is a depression at the top end of the leaf. There are a large number of strong veins, as well as small ones forming a network over the whole surface of the leaf, and the edges are coarsely serrated. The surface of the leaves is dark and sticky, the latter feature being responsible for the tree's specific name, *glutinosa* (Latin for gluey).

Catkins are a feature of the alder almost throughout the year, as they are of the birch, and the two trees are, as a matter of fact, members of the same family. The male catkins of the alder, which are of the reddish-brown colour that is characteristic of the whole tree, contain a large number of flowers, each consisting of a red scale, which bears four stamens. When fully open they are some two inches in length, but the individual flowers are minute. The female catkins are much smaller, only from half to a quarter of an inch in length; they are also hard and woody owing to the stiff bracts which cover the fleshy scales, each of which bears the pistil. They are grown on little stalks that branch off from those bearing the male catkins, and, as the illustration below shows, are at first visible as tiny knobs. Both male and female catkins are, therefore, found on the

IN THE SPRING SUNSHINE

This beautiful photograph shows the alder's long, pendent catkins that bear the male flowers. The tiny female catkins, as yet undeveloped, are visible as blackish knobs at the tips of the offshoots from the stalks bearing the male catkins.

same tree, and such are their size and colour that the alder seems much less naked than does even the birch during the leafless season. They are early catkins, being in flower in March in most years; hanging in purple festoons from the dark branches, they surround the whole tree with a haze that gives a welcome warmth to the cold light of early spring.

EVEN before the catkins are out the alder bears a noticeable feature in the hard little cones that form the fruits, for these persist throughout the winter even after the seeds have fallen. For this reason an alder is never completely bare—at least, not after it has attained an age of twenty years, before which time it does not bear fruit. But, unlike many other late-maturing trees, it bears a plenteous crop every year once it has begun to fruit; the cones themselves are ripe by the late autumn, and, as the scales spread apart, the myriad seeds fall out and often cover the surface of eddies where the ripples of the stream swirl under the roots of the tree.

In stature the alder is never very imposing, and, although it may grow to as great a height as seventy feet, it rarely attains over half that height. The bole, which is from three to six feet in diameter, is, in common with the rest of the tree, rough in texture and very dark reddish-brown; when, as is frequently the case, part of it is under water, that portion is quite black. But, unfortunately for the appearance of the tree, there are often a number of small stems rising from the same base instead of a single, straight bole. Where these exist—and they occur in most situations—the alder is little more than a comparatively insignificant shrub. But, tree or shrub, the roots of the alder are of great economic value; thick, numerous and matted, they are more useful than any arrangement of barriers and piles to keep the rivers within bounds, and prevent the banks from collapsing into the water. A row of alders closely clinging to the sides of a stream clearly marks out its course from afar, and when we see a winding line of these trees in the middle of a flat expanse of water meadows, we may be sure that it is beneath their shade that the stream makes its way, held in by their twining roots.

S. V. Waters

CATKIN CHARACTERS

Seen close-up (they are here reproduced slightly more than natural size), the alder catkins exhibit many features that we are liable to miss at a first cursory glance. Here the innumerable black dots are the stamens, while the way in which the catkin is separated into flowers is also shown.

OF EXCEPTIONAL SIZE

The alder is usually a smallish tree, or has merely a number of small trunks. In this photograph, however, we see a really fine specimen—one with a bole that can compare with that of many of our forest trees. The rough bark is not deeply fissured, and there is a typical mass of shoots and suckers round the base.

E. J. Hosking

Where the Alder is at Its Best

IT must be noted, however, that not every moist situation suits the alder. A porous soil, for instance, though it may support other moisture-loving trees, dwarfs the alder's growth and turns it into a mere series of bushes. To see the tree at its best we should seek a stream that has its origins in the depths of a well-wooded hill, where the soil is rich, and whence, as it flows down to the plains, it carries with it a generous proportion of rich, leafy humus, producing the loamy soil that the alder loves. A further point in the distribution of the alder is that it prefers to have its head as well as its lower parts in a humid atmosphere, so that a position on the shady banks of a river that runs in a deep valley amongst other trees, suits it better than does a more open site, where the river flows through bare fields.

The alder is of little value as timber, for it is a quick-growing tree and the wood is consequently soft. White

so long as the tree is alive, alder wood turns a fine reddish colour on exposure to the air, and dries finally to a pleasant pinkish hue. The sole use to which it is put as timber is for the strong piles of river banks: in such situations, where it must be submerged probably for the whole year, it shows qualities of endurance such as are found in none of our other native timbers. Piers for bridges, which have to undergo the same conditions as piles, are likewise sometimes made of alder; it is also used for the staves of water barrels, and in France alder is the chief wood employed in the making of the country people's *sabots*, or clogs. It is also said to be of considerable value for the weather-boards of houses, for which purpose, indeed, some authorities consider it a rival to the beech and elm.

Special Uses for Alder Wood

As is often the case, the turner and cabinet-maker welcome the wood for which the timber merchant has little use, and alder is one of the most widely used woods for the art of the carver. When soaked in water for some time, it does not deteriorate, but becomes very hard, and alder logs that have been for many years in peat bogs are as black as ebony. The feature that makes this wood valuable to the cabinet-maker is that it is very knotty, and can therefore be used as a substitute for various other woods, especially maple. Finally, alder is said to make extremely fine charcoal, and is, in fact, the wood most used for that purpose in gunpowder mills.

Waters; Hosking

CONES OF THE ALDER

Similar in shape to those of the cedar shown in page 368, the alder cones are much smaller (above they are seen natural size) and arranged in a very different manner. Inset, on a reduced scale, is a spray of alder leaves.

H. Bastin

GUARDIANS OF THE STREAM

Alders are frequently found beside a stream, and their presence not only contributes to the beauty of the scene, but is of material advantage, for their roots help to keep the current within bounds. The trunks are usually small and numerous, each clump arising from one submerged rootstock.

As one of the few trees that thrive well in moist sites, where it is even more at home than are the willows themselves, the alder is bound to attract a numerous insect fauna. One of the most noteworthy of the insects that feeds on it is the alder saw-fly. Its larvae are only half an inch or so in length, and are remarkable for being covered with a layer of white mealy down, which gives them the appearance of bird-droppings, and thus serves as a protective resemblance.

Flies that Haunt the Alder

A member of the order Hymenoptera (which includes the bees and wasps), the alder saw-fly is one of the outstanding representatives of the division known as the *Sessiliventres* (Lat. *sessilis*, sitting; *venter*, belly), so called because in them the abdomen is joined firmly to the thorax and not separated by a narrow waist as in the wasps, bees and ants. Its larvae closely resemble the caterpillars of butterflies and moths, and can, in fact, only be distinguished from them by the non-specialist by their larger number of abdominal legs.

An insect wholly characteristic of the alder is the alder fly, a description of which is given in Chapter 4

British Museum (Natural History)

UNITED THEY STAND

The trunks of this alder show a sharp contrast to the bole, strong and wide-girthed, depicted in page 400, for they are numerous, slight and slender. The tall, straight stems of the mature tree are well seen in its winter nudity.

of the section, Wonders of Insect Life, page 198. The eggs of this fly, which is a member of the order Neuroptera, are often to be found in serried masses on the stems of plants near the water and sometimes on stones at the very water's edge. The adult flies, largish, brown-winged creatures whose wings are raised tent-like over their backs, rest in hundreds on the trunks of the alders; they rise, flying feebly and aimlessly, only to return to their perch or fall into the stream. Their adult life is apparently purposeless, their sole function seeming to be that of preserving the "balance of Nature," for they are, in all stages of their existence, among the chief foods of freshwater fish.

AMONG the moths found on this tree, the alder kitten, a small cousin of the well-known puss moth, is described in the section dealing with Our Butterflies and Moths. Preston in Lancashire and the Tilgate Forest in Sussex appear to be its headquarters, but alder trees in all parts of the country have yielded specimens at one time or another. The caterpillar is yellow-green, with a purple-brown band along the back; it feeds on birch as well as alder, but, as its name indicates, has a decided preference for the latter tree. The alder moth, a member of the great group of moths known as the Noctuids (Lat. *noctua*, night-owl), is a considerable rarity. Its caterpillar is quite as remarkable as that of the alder kitten; it is black, with yellow bands on each segment of the body, and has a number of long, curiously clubbed hairs. But in spite of its very noticeable coloration it is rarely encountered, although specimens have been found in almost every county of England as far north as Yorkshire, while Wales and Ireland have yielded a few. The moth itself is a very handsome insect, with its greyish fore-wings clouded along their rear portions with greenish-black, while the basal area is lighter, yellowish-grey. The rear wings are pure white, and are semi-transparent owing to the sparsity of the scales.

Birds in the Alder's Boughs

THERE are few birds that have an intimate connexion with the alder tree, but its branches form a welcome perch for the kingfishers and innumerable warblers that haunt the riversides during the hot summer months. Where they line the meadows, these trees are also often chosen for roosting by the flocks of starlings that forage in the wet soil, and in winter flocks of thrushes and fieldfares find them similarly useful.

Anglers are given to praising the alder, for it provides them with shade during the heat of a summer's day

Crawford; Ward

ALDER FAUNA

The alder fly (left) and the caterpillar of the alder moth (right) are two characteristic insects that are connected with the alder —the first being very fond of sitting on the trunk, while the second devours the leaves. As pictured here, the fly is some three times natural size, and the caterpillar twice natural size.

and shelter from the icy winds of winter. A further, but less obvious advantage accrues from the tree's strong roots. These bind the bank together, but the stream, swirling against the sturdy roots, forms deep holes which become the homes of large fish. Many a famous pool owes its origin to the alders which have permitted the water to scour a deep hole without completely destroying the bank. Such holes as these are the favourite haunts of chub, whose dashes entangle the angler's line among the alder roots.

ALDER IN SUMMERTIME

To a greater extent than any other of our trees, the alder is a lover of the watery place, and it must be sought along the banks of streams or beside the marsh and swamp

Neville Kingston and M. H. Crawford

SPIDER CRABS AT CLOSE QUARTERS

Although not so commonly encountered as the shore crab, spider crabs are to be found in almost all districts around the coast of Britain. They are of many kinds, and may have either large shells and correspondingly long legs, or almost insignificant bodies and legs so long that the animals appear to be composed almost entirely of limbs. The two spider crabs shown above are fighting over a tasty morsel which one of them has found on the sandy bottom, while below can be seen a slender spider crab resting beneath waving fronds of seaweed

J. T. Roberts

WATER SPIDER MANOEUVRES

Unenviable seems the lot of the water spider, for, an air-breathing creature, it must seek its food only under water. Yet it has surmounted with brilliant ingenuity the dilemma in which it finds itself, for it carries about with it in its subaqueous prowlings an aery diving dress, seen in these photographs as a white enclosing line, beside which, says M. Maeterlinck, "our appliances for submarine exploration . . . are clumsy and childishly complicated monsters." In the upper photographs the spider is taking further air to its nest, and below it is making its nest secure

E. J. Hosking

DOMESTIC INTERLUDE

Though the nightingale sings throughout the day and a great part of the night, it is not neglectful of its domestic duties, and in this photograph we see the parent bird listening with obvious solicitude to the cries of the callow youngsters in the nest. Altogether helpless though the newcomers seem to be, they will have become sufficiently "grown up" to accompany their parents on the flight to Africa in September

THE NIGHTINGALE AND ITS GLORIOUS SONG

As we are reminded in the chapter that follows, its superb song has won for the nightingale boundless fame. Even the most unmusical, to whom the notes of the avian choristers as a rule make small appeal, will sit up of a night to listen to the magic notes uttered in, perhaps, some quiet Surrey wood and broadcast to a million homes. In this chapter many less-known facts about the nightingale are set forth, and something is said, too, of the mechanism of bird song

Probably no bird is so famous for its song as the nightingale. Poets have celebrated it in verse and song, naturalists have delighted to write pages in its praise, millions of listeners to wireless programmes have heard its notes, and even the most hardened ornithologist must descend from the purely descriptive to a more enthusiastic tone when he comes to describe this bird.

Yet the number of persons who have knowingly seen the nightingale is remarkably small. Not that it is particularly scarce, although it is confined to the area south of a line drawn from the south of Yorkshire to the borders of Wales. The small number of those people who are, so to speak, personally acquainted with the nightingale is due, in part, to the bird's quiet colouring and unobtrusive habits, but even more to lack of observation on the part of naturalists themselves Most people seem to be under the impression, for instance, that the nightingale sings only at night, and consequently they never look for it during the daytime, and, in fact, fail to recognize its song even when they do hear it during the day. In this connexion Lord Grey of Fallodon tells a story of how he was sitting in broad daylight by the roadside, listening to a nightingale that was in full song in the opposite hedge, while passers-by merely stared at him and wondered what he was doing!

There is no doubt that the nightingale's habit of singing at night as well as in the daylight hours, is in some measure responsible for its fame, for it has the advantage of singing at a time when its rivals are silent. At the same time, there can be no doubt of the superb, the almost unearthly quality of its notes. Lord Grey, undoubtedly one of the best qualified to write on bird song, calls it "marvellous," and it is from his book, "The Charm of Birds," that we may quote, in preference to the more famous, but hardly more expressive, odes of Wordsworth and Keats. "The supreme achievement of the nightingale," he writes, "is a loud, clear, sustained note that fills the air—the supreme notes of the nightingale envelop and surround us: it is as if we were included and embraced in pervading sound." Its notes, he says further, are of "an energy, a force, and dominance" with which those of no other birds can compare, and this is true, moreover, whether we consider British birds or those of all the world.

INIMITABLE SONGSTER

Here we see the nightingale, most famous of all singing birds, perched in the pose he favours for his performance. Incidentally, by this pose as well as by his build we know him to be no warbler, but a relative of the robin and the thrush

P Bruder

O. G. Pike

PERFECT POISE

Alighting on a branch, the nightingale opens its long tail, for this helps it materially in maintaining its balance. This picture shows admirably the nightingale's form, so distinct from that of the warblers whose pictures are seen in pages 453 to 456.

An extraordinary feature of the nightingale's song is that it does not consist of a number of phrases, but rather of a repetition of several notes, in this respect resembling the song of the song thrush. The single note referred to by Lord Grey is, indeed, so compelling that there is no mistaking it, and, once heard, it can never be forgotten. It is repeated again and again, in what Mr. Warde Fowler describes as "that marvellous crescendo on a single note which no other birds attempt."

Unfortunately, it is not every nightingale that can reach these heights. We may listen to several without ever hearing a song that is much better than that of the blackcap or the garden warbler, and then suddenly we come across a nightingale whose voice is of a quality that brings us, too, to the bird's feet in awe. Then, and only then, do we admit that this is indeed a songster worthy of all the praise that poets and prosemen have showered upon it in such lavish measure.

Near Relations of the Nightingale

Mention of the similarity, in form at least, of the songs of the nightingale and the song thrush gives us a clue to the nightingale's identity. It must be realized that, although many authorities have included the nightingale in the same category as the warblers, presumably on account of its reputation as a songster, its colouring and its retiring habits, yet it is really a member of the thrush family. This family also includes the robin, and anyone who watches the nightingale at the nest, or as it sings among the bushes or grubs about for food, will have no difficulty in seeing this for himself. The nightingale looks, in fact, like a large, dull brown robin.

In plumage the nightingale is reddish-brown above, dull brownish-white below; there is a greyer patch at the side of the neck, below and behind the eye, but this cannot be seen when the bird is moving about.

The nightingale prefers the thick, bushy places to the open, being found most often in woods where there is plenty of thick undergrowth, in coppices, or in dense, natural shrubberies. The nest, built on or near the ground, is made of leaves, usually those of the oak, mixed with a certain amount of grass, and lined with grass and hair. The eggs are of a very characteristic

R. Gaze

NIGHTINGALE RETREAT

The eggs of the nightingale are very distinctive, of a uniform darkish olive-brown. The deep nest, made of grass and leaves, is situated on or near the ground—often, as seen in this photograph, among brambles at the base of a thicket.

olive-brown colour all over, unlike those of any other of our birds. They are from four to six in number, and only one brood is laid. This last fact limits the singing season, which is unusually short, extending only from early May to about the middle of June.

Anyone who has listened with rapture to the golden notes of the nightingale may well have wondered how it is that so small a bird can produce so great a volume of sound and, further, how the actual notes are produced. The following brief account may in some small measure help to elucidate what is still—in part, at least—among the mysteries of ornithological science. The voice of the bird is produced, not, as in the case of Man and the other mammals, by means of the vocal chords, but from what may be described as a "song-box," or, as the scientists

call it, a syrinx (in ancient Greece a *syrinx* was a pipe on which music was played).

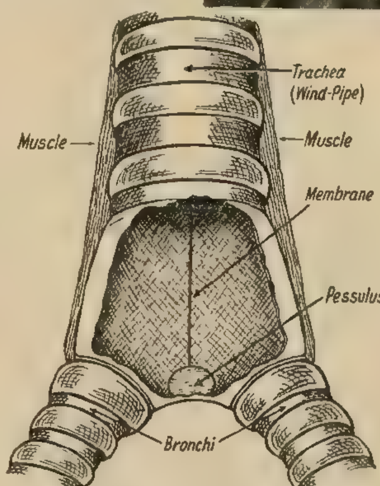
This syrinx is placed at the bottom of the windpipe of the bird, at a point where it divides to form the two bronchi, or air-tunnels, which run one to either lung.

The lower rings composing the outer wall of the windpipe, and the uppermost rings of the bronchi, are hardened to form a sort of bony box. This box is crossed by a bony bar, known as the pessulus, which supports a vibratile membrane, called the "reed." This membrane is attached to one side only of the windpipe, and there is a gap between its farther edge and the opposite wall. From this wall a fleshy lip projects towards the edge of the reed, in such a way that the gap between them can vary in width. Furthermore, the walls of the windpipe and of the bronchi can expand and contract to a remarkable degree, so that their diameters vary enormously. When the bird sings, air is forced at great pressure from the lungs, and from the air-sacs which are situated in various parts of the body, along the bronchi, and into the syrinx. According to the pressure of this air the reed vibrates, and produces a note of a certain quality. In addition to the apparatus described above, the bird has a set of seven pairs of important muscles which run from the windpipe to the walls of the bronchi and to the syrinx, and it is by these muscles that the bronchi and windpipe can be expanded and contracted, thus providing further control over the air within the pipe.

O. G. Pike

LEAVING HOME

Well-fledged, though certainly not quite ready to fly, this young nightingale seems to be taking advantage of its parents' absence in order to explore the outside world. Judging from the expression on its face, however, it is none too sure of its powers of locomotion.



SONG'S SOURCE

The syrinx, or bird's song-box, is formed by the development of a bony plate at the junction of the windpipe (trachea) and its two branches (bronchi). Inside the chamber formed by this plate is the vibrating membrane. The other parts of the organ and its operation are described in the accompanying text.

Unsolved Mystery of Bird-Song

As regards the structure of the syrinx there is an enormous amount of variation in the different orders of birds. The formation described above is more or less typical of the Passeres, the group containing the finest songsters. In some other groups, in which there is little or no true song, there may be, for instance, only one pair of muscles connecting the windpipe to the syrinx, and the syrinx generally is less complex in structure. It must be realized, however, that the real reason for the quality of any one bird's song, or for the superiority of that of the nightingale over that of other birds, cannot be satisfactorily explained. There is, for instance, no real difference, so far as can be ascertained, between the syrinx of the nightingale and that of the rook.

HOW TO RECOGNIZE BIRD SONGS

Many beginners in the field of ornithology will find it extremely difficult to distinguish between many of our smaller birds. With a certain amount of practice, however, and with the aid of one or two really good books, one can learn an enormous amount, not only about birds that one sees, but also about species one has never seen. A point that will help more than any other is that of learning all that can be learnt about a bird's song.

In the chapters on Our Birds we have given, wherever possible, a description of the song, from the point of view of the listener. The impression given by the song, be it one of joy, or quiet satisfaction, or even boredom, is described. This is often a valuable clue. No one, for instance, having read about the skylark, should fail to recognize that song, even if only from the manner of the bird's performance, and though most songs are not by any means so easy to distinguish in this way, they will often give a useful pointer to the songster's identity.

Hearing Before Sight

When listening to the song of any bird, it is often advisable not to try to see the bird, at least while it is singing. A slight noise or movement may frighten the songster, and we cannot listen so well when we are at the same time trying to catch sight of the bird. Often, too, the song is delivered when the bird is hopping about in thick bushes or undergrowth. The best plan is to listen to the song until we have a definite impression of the phrasing, and then to try to see the bird.

In the case of the warblers, our principal songsters, the song is a far better way of telling which bird one is watching: but, on the other hand, the songs of a number of species are so alike, to the beginner at least, that until we can be sure of them we must try to rely on our eyes, not our ears. Once the songs can be recognized apart, it is enough to hear just a few notes to tell us what bird we are listening to.

The manner of the delivery, too, is important. Say, for instance, that we have read of a certain bird as always singing from a perch. On a ramble we may notice a perched songster, but cannot get close enough to have more than a general idea of the plumage. By checking the singing habit and song with what is seen of the plumage, we can decide whether or not the bird seen is what we suspect it to be.

CRAB DEVELOPMENT FROM EGG TO ADULT

DURING the summer months in particular the seaside beach is patrolled and examined by many thousands of visitors from inland, to whom its varied life comes with the wonder born of unfamiliarity. Starfish and sea-anemones are dealt with in other chapters in this series (*see* pages 204 and 289); and now in the chapter below the reader is introduced to the crab, particular attention being paid to the general characteristics

PERHAPS the commonest of all the forms of animal life seen on the seashore is the crab, of which sixty distinct species are known as natives of the British coast. These sixty species are divided up into small groups, comprising such well-known types as the swimming crabs, the spider crabs and the hermit crabs. In Britain there are no land crabs—although the shore crab (*Carcinus maenas*) spends most of its time out of the water—nor are there any freshwater crabs, a fact as yet unexplained, though the comparative shortness of English rivers and the smallness of the lakes may have something to do with it.

Crabs are crustaceans and are examples of a group of animals which, instead of being supplied with a bony interior structure, like the vertebrates, have a hard outer covering, known as an *exoskeleton*, in which their muscles and all their organs are contained. Crabs belong to an order of the crustacea known as the *Decapoda*, and are all contained in the section *Brachyura*. They are classed apart from the lobsters and the shrimps owing to the smallness of their abdomens and the shortness of their tails, which lie folded up beneath their shells at the back. The carapace, or shell, is usually triangular, and is somewhat flattened, so that its depth is never more than about one-fifth of its breadth. Its colour varies greatly with different species, and may be anything from green to red. There are always five pairs of jointed legs, of the same colour as the shell. The muscles of these legs, like those in the body, are covered by the exoskeleton, and, consequently, instead of pulling over the surfaces of the bones, as in the vertebrates, the action of the muscles takes place entirely within the hardened walls, the resulting strains and stresses being completely different.

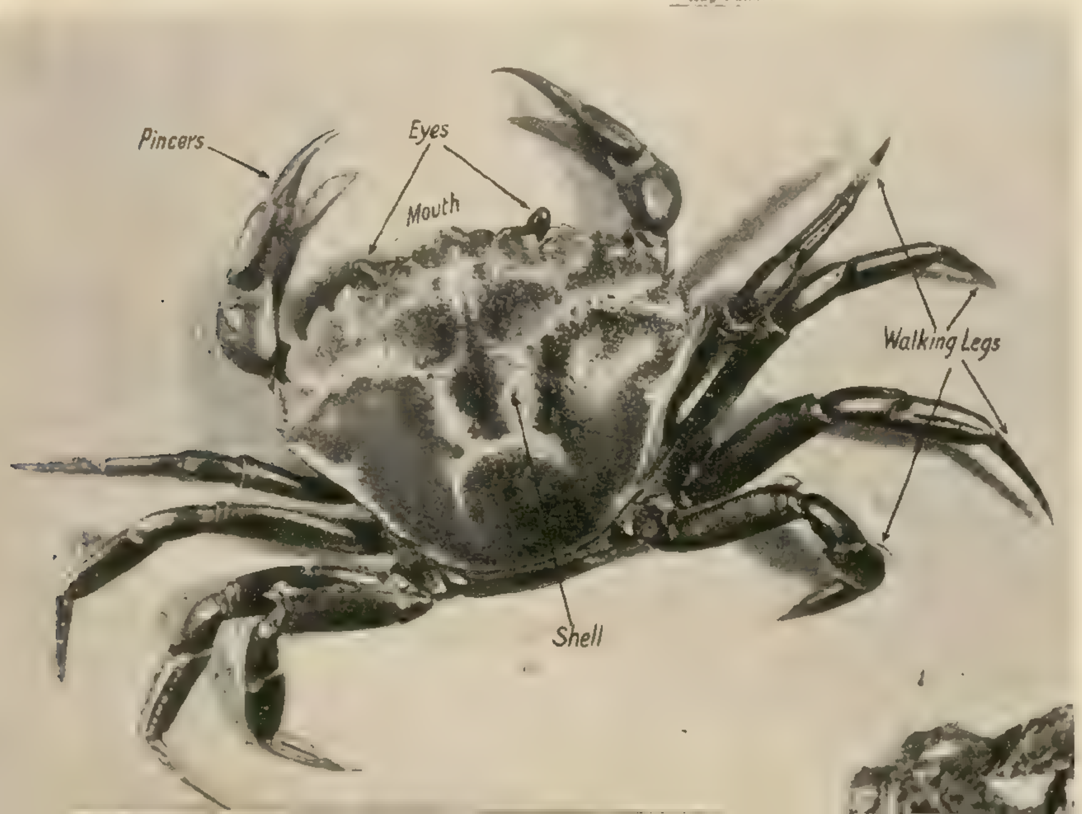
ON the first pair of legs, or *chelipeds*, those nearest the mouth-parts, are the characteristic nippers, or *chelae*, which are relatively very strong; their skeletons are much larger than those of the other legs, and the muscles contained in them are correspondingly increased in size. In the edible crab these muscles are often considered the most tasty portion. The chelipeds are not used much in the process of locomotion and only in a few specialized species when the crab is swimming. As would be expected, the crab with its four pairs of walking legs is capable of moving quite quickly, both on wet sand and under the water, while one noticeable feature is the way in which it runs sideways. This sidling method of progression, it may be mentioned, is due to the peculiar way in which the crab's walking legs are jointed; as it moves, the crab's head is always to the side, but the formation of its eyes described below obviates the disadvantage which might otherwise arise. At the ends of the four pairs of walking legs are spiked appendages, which easily grip into the sand or any irregularities in the surface of the rocks on which the animal lives.

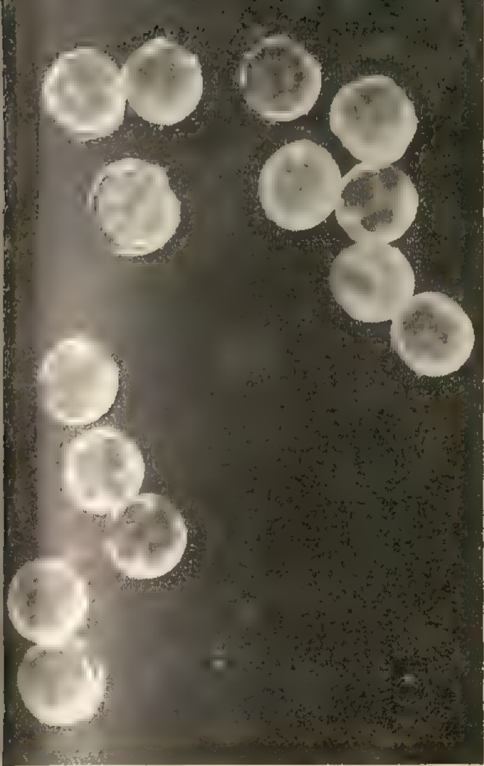
The eyes of the crab are set on movable stalks, so that they can be shot out and in after the manner of a telescope. They are situated on either side of the mouth-parts on the front of the shells. The crab can see both in the water and out of it, though its sight is never very keen. When drawn right inside the eye-sockets of the shell, these retractile eyes are completely out of harm's way and cannot be damaged by the attacks of enemies or by the rough surface of stones. Like those of the snail, the eyes of the crab are retracted as soon as the animal is picked up or disturbed in any way.

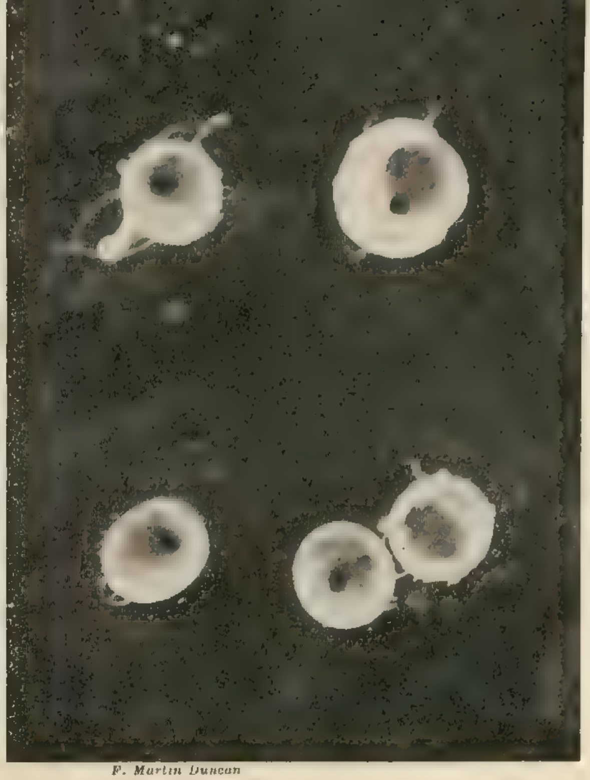
SALIENT FEATURES

Of the sixty species of crabs found in Britain, the commonest is the shore crab (*Carcinus maenas*). It is this crab which is illustrated below as a typical specimen of the crab family.

Ray Palmer







F. Martin Duncan

CRAB BEGINNINGS

In the picture on the left, above, we see the eggs of the shore crab undergoing the segmentation which follows immediately after fertilization. On the right, the eggs have reached the stage when the larvae are endeavouring to escape. The large eyes of these embryo crabs can be seen through the egg-membrane. (Both photographs × 80.)

The crab's mouth-parts, like those of most crustaceans, are extremely complicated and consist of a number of adapted appendages, all of which have evolved from the simpler appendages of the extinct archetypal forms. The crab has six pairs of appendages adapted as mouth-parts, which are known as the mandibles, first and second maxillae, and first, second and third maxillipeds. The first three pairs of appendages form the antennules, antennae and the eyes.

All this array of limbs and mouth-parts does not complete the crab's set of appendages, for there are also a large number of feelers and greatly reduced limbs on the under-surface, which play an important part in the process of reproduction. The front pair of legs, for example, are used by the male crab in holding the female during mating, while those found in the same position in the females carry the eggs after fertilization. The female crab may be distinguished from the male by the abdomen, which is always far larger in the female owing to the presence of the specialized tissues used in the production of the eggs.

Like the spiders, the crabs breathe by means of modified appendages which, since they are adapted for an aquatic existence, are called gill-books. In all crabs the gills are found on the underside of the body, and are fewer than in either the lobsters or the crayfish, never exceeding more than nine on each side. Since the crab spends much of its time on dry land, these breathing appendages have to be capable of absorbing oxygen both from the air and from water. It is clear that if a respiratory organ can absorb oxygen from water, it should also be able to do so from the air, where the percentage of oxygen per unit volume is far greater. It follows, therefore, that if there were no other hindrances to such an alteration in habits, all aquatic animals could quite easily breathe our atmosphere and still be supplied with as much oxygen as they would require. There are, however, so many other difficulties, such as the tendency of the gills to collapse or to become entangled with one another, that in such organisms as the crab's, in order that the respiratory organs may be capable of breathing both air and water, they have to be thoroughly protected with a hard outer casing. A point to be noticed is that, although a water-breathing organ may be adapted to a land-living

NEARING ADOLESCENCE

Below, left, young zoeae. On the right we see the final larval or megalopa stage. Note the latter's stalked eyes and the tail, protruded when swimming and tucked in when at rest. A zoea is smaller than a pin's head; a megalopa is about ⅛ in. long.

F. Martin Duncan

E. Step

FECUND INDEED

Above is shown the underside of a female velvet fiddler crab, on which the eggs are borne in huge numbers like some parasitical growth. "Velvet" in its name refers to the dense covering of bristles on its shell, and "fiddler" to the characteristic way in which it holds its claws.

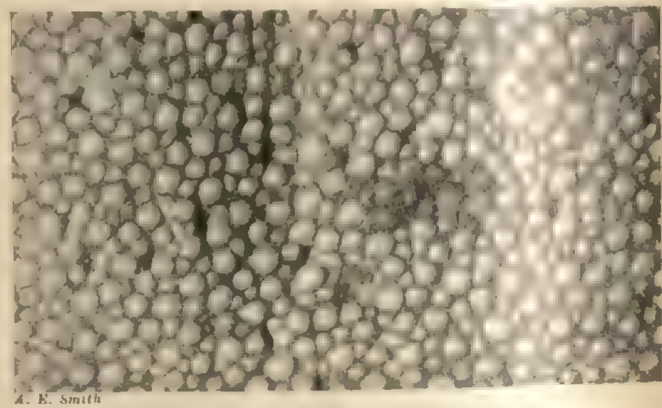
existence, an air-breathing organ or lung can never be made to suit either the increased pressure of the water or its relatively low oxygen content. Many such problems, which are presented to the scientist by the littoral forms of life, are being investigated in laboratories all over the world, and present-day biologists are devoting much time to this fascinating phase of zoological study.

Stages in Crab Development

In common with most crustaceans, the young crab which comes out of the egg bears very little resemblance to its parents, and is known as a larva. The larval history of the common shore crab is typical of the histories of the development of other genera and species in the order. The very earliest stage is that known as the *zoea*, when the head of the larva, as well as the forepart of the body, is covered by a shield, which soon grows two long spines, one sticking up from the middle of the back and the other out in front like a beak. Behind the part of the body covered by the shell there is the long abdomen, which is jointed and can be freely bent backwards and forwards. The end of the abdomen is tipped with a forked "fin" used in swimming. The eyes are very large and are set close together in the front, but not on stalks as in the adult, while behind the beak-like frontal spine there are a number of antennae as well as swimming feet, which correspond to the adult jaw appendages. The little animal has as yet no true feet.

Since the shell covering the larva is hard and incapable of growth, this has to be cast or "moulted" at intervals as the individual increases in size. When still in the zoea stage the larva, by means of its limbs, swims about near the surface of the sea and moults until—after, according to some authorities, five moults—a new form is assumed, that of the *megalopa* ("big-eyes"). Now the spines vanish from the shell, and, the legs appearing, the new larva not only can swim, but is also capable of crawling along the bottom. The abdomen at this stage is stretched out like a tail behind the shell, as in the lobster, and on the end of this extension are the swimmerets—little flat plates which aid the megalopa in swimming. It swims so fast, indeed, that it is usually able to outdistance the many foes that lie in wait, although many a zoea falls a victim to a cannibalistic megalopa of its own race. Soon, by a series of moults—some say, three—the shape and appearance of the adult are assumed, and from now onwards, by moulting at regular intervals, the tiny crab grows into the full-sized adult in about three years' time.

In all these various stages the crab-larvae are preyed upon by the larger fish which consume great quantities



A. E. Smith

JUST A CRAB'S SHELL

In this photograph we see what a section of a crab's shell looks like when seen through a microscope. The shell shown in this picture is magnified by ten diameters.

of planktonic life, filtering the water in their mouths. It is only when the crabs become sufficiently large that they are able to escape the attentions of their natural enemies and to dig into the soft sand of the bottom at the approach of danger.

HOW TO PRESS SEAWEED. 2

There is a great deal more skill in the art of collecting, pressing and preserving seaweeds than the amateur naturalist is generally led to believe. Specimens of seaweed, neatly and artistically arranged on stiff pieces of cartridge paper, are not as easily come by as might be supposed. There is so much to learn that the would-be seaweed collector is often deterred from continuing with his collection by his failure to preserve specimens to his satisfaction.

Although many seaweeds require some adhesive substance, such as gum, to stick them in place on sheets of paper, by far the majority of species stick to the paper of their own accord.

One of the most important stages in the preparation of specimens is the pressing. The seaweeds should be placed flat between two pieces of linen, and then enclosed between sheets of coarse (botanical) blotting paper. Thus they are partially dried, and until this is done the specimens should never be pressed.

Home-made Press

A useful seaweed press—which may also be used for pressing other botanical specimens—can be made from two pieces of wood, about 10 in. by 8 in. by 1 in., fitted with butterfly screws at each corner, so that they may be tightened up together. The bolts for the butterfly nuts should be firmly fitted into the lower board, one at each corner, the top board having four corresponding holes. When these bolts have been slipped through the holes and the nuts screwed on, the press is complete. If a specimen is inserted between the boards, by adjusting the screws any tension required can be obtained. The total cost of making this instrument is but a shilling or two and it can be made in any size which may happen to be convenient.

The tension of the press should be adjusted to the types of seaweeds in preparation. Very large and bulky specimens can withstand far more pressing than fine and delicate ones. When the specimens have been in the press for some two or three hours, the blotting paper should be removed and some fresh pieces put in, but the pieces of linen need not be touched. At intervals of twelve hours or so this process should be repeated for several days. At the end of that time the linen can be removed and the seaweeds transferred to dry paper. If necessary they can be pressed a second time.

FOSSIL REMAINS OF PRIMEVAL TIMES

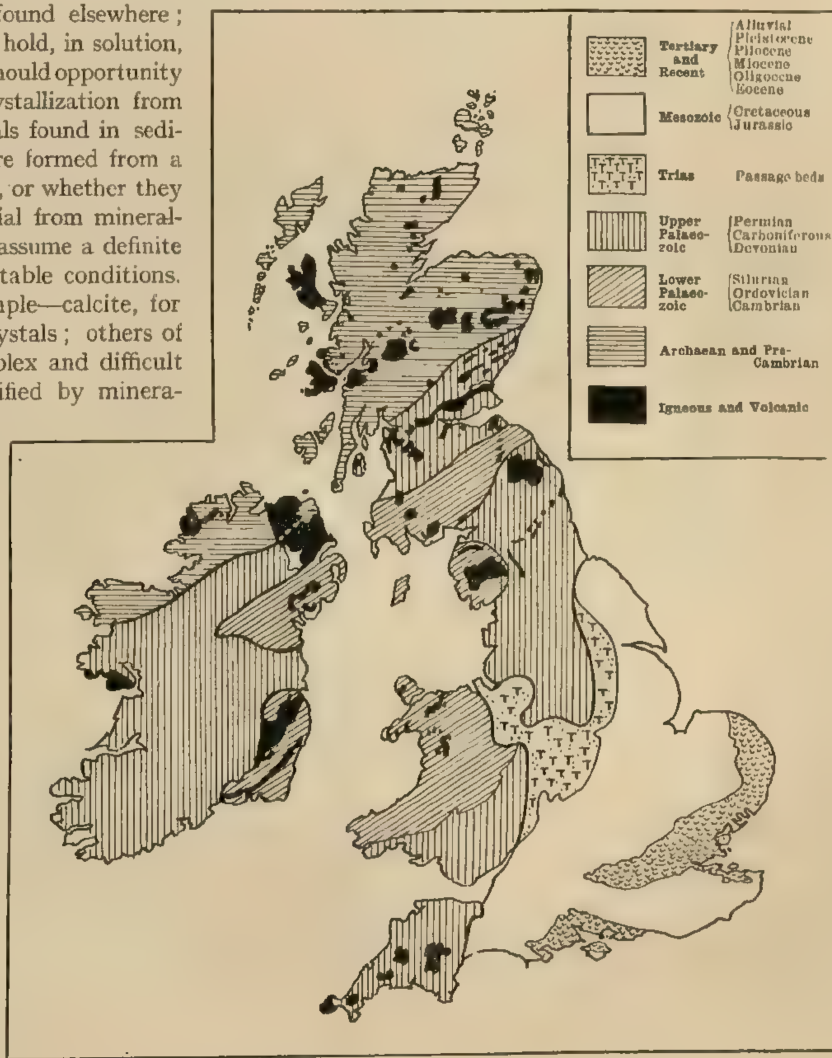
THE history of Britain is immensely longer than the period covered by most of our history-books. Thousands, tens of thousands, hundreds of thousands, millions—of years ago the landscape of our land was in the process of becoming what we see it to be today; and in the rocks, lying hidden until they are revealed by the pick of the miner, the charge of the quarryman, or the hammer of the geologist, are traces of that enormously distant past

THERE is a popular guessing game in which the first lead to discovering what a person has thought of is the question: "Animal, vegetable, or mineral?" Mineral is a word that has wide variations of meaning, but in geological terminology it denotes a substance which has a definite chemical composition, internal structure and external form, into which it may or may not crystallize according to the conditions under which it came into being.

It has been shown that granite is largely composed of the minerals quartz, mica and felspar, and that basalt contains many fine, dark crystals. It is, therefore, clear that igneous rocks possess minerals as an integral part of their structure. But minerals can be found elsewhere; water percolating through the rocks may hold, in solution, mineral matter that would crystallize out should opportunity occur. A common example of such crystallization from solution can be seen in the calcite crystals found in sedimentary rocks. But whether crystals are formed from a molten flux that is allowed to cool slowly, or whether they grow from the slow deposition of material from mineral-charged water, they will always tend to assume a definite shape, which they will attain, given suitable conditions. Some of these crystalline forms are simple—calcite, for example, is found commonly in cubic crystals; others of these geometrical shapes are more complex and difficult to comprehend. All crystals are classified by mineralogists according to the degree of symmetry to which they can attain under favourable conditions, in addition to a classification by chemical content.

QUARTZ, felspar, mica, calcite, hornblende and augite are some of the commonest rock-forming minerals of the British Isles, and may be found without difficulty. From their character it will be clear that it is useless to attempt to form a collection of minerals by searching the sedimentary rocks, though calcite and iron pyrites may be found in this way. Most of our British minerals must be looked for in the masses of igneous rocks, such as the granites and dolerites, which have cooled slowly at a great depth, thus allowing the minerals to grow to a comparatively large size and assume their true shape. There are few precious minerals or ores of economic importance in the British Isles. The mineralized portions of Cornwall, it is true, produce a little zinc, copper and other ores, and the sedimentary iron deposits of eastern England are of great commercial value; with these exceptions our ores are imported. Coal, of course, though a mineral, is not an ore.

Those who live far away from districts where they can collect minerals usually have compensation in the abundant store of fossils in the sedimentary rocks. Fossils are the remains of animals and plants that lived and flourished millions of years ago. The majority of these fossils are the relics of marine forms of life that lived and died in the sea, becoming buried under the gradual accumulation of sand and mud deposited on the sea bottom; but some are land-living forms that were buried in



BRITAIN'S GEOLOGICAL DIVISIONS

A detailed geological map of the British Isles is exceedingly complicated, but the principal divisions may be readily grasped from this sketch map. Geologically speaking, the north-western districts are the oldest.

British Museum (Natural History)

FOSSILIZED FISH

Most fossils are found dispersed through strata, but occasionally a thick bed of fossils is found. The fishes, for instance, whose fossilized forms, unearthed from a bed of Devonian sandstone, are seen above, must have been crowded together in a pool which rapidly dried up. There they died, and their remains became covered by subsequent deposits.

terrestrial deposits or else were swept down to the sea by rivers. Thus, we find their petrified remains in many of the secondary rocks, and the study of these long-dead animals and plants forms the science of *Palaeontology* (Gr. *palaios*, old; *onta*, beings; *logos*, science), which is one of the most fascinating branches of geology. It is usually only the

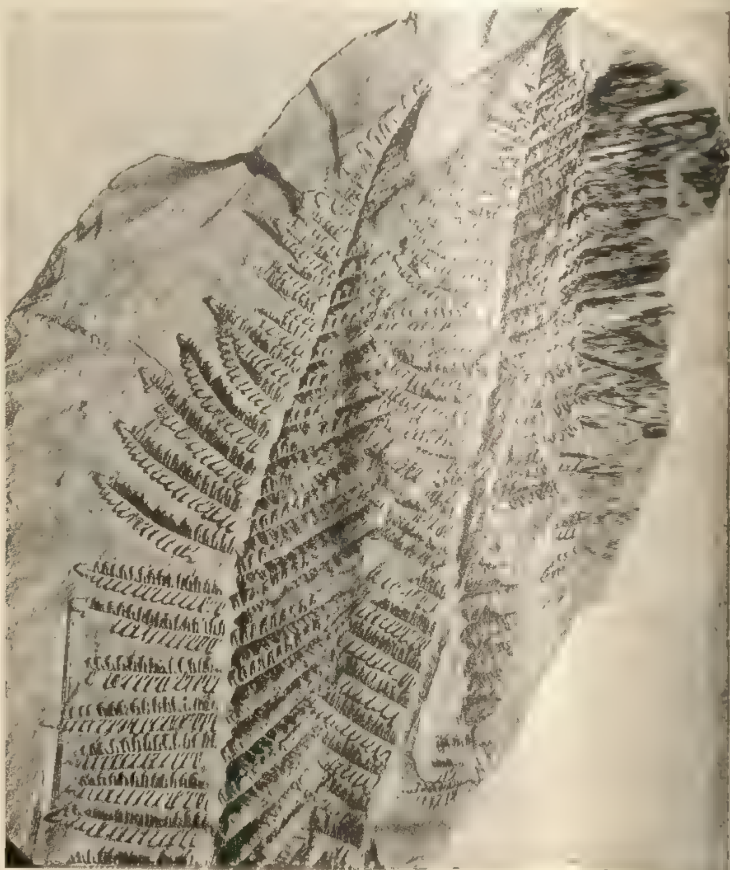
PRISONED IN ROCK

Concretionary nodules, or rounded lumps of rock, have been formed by grains of sediment collecting round some solid object. These nodules are always worth examining for fossils, as is proved by this photograph of a typical nodule split in half. Inside is a well-preserved fossil ammonite.

hard parts of the animals that are preserved, such as the external skeletons of the invertebrates and the internal skeletons of the vertebrates, but these are quite sufficient to give a clear idea of the various types of animal life that flourished in the different geological epochs.

The first to realize the importance of fossils in systematic geology was William Smith (1769–1839), sometimes known as the "Father of English Geology." Though fossils had been collected before his time, Smith was the first man to recognize their importance in classifying strata, and between 1794 and 1822 he produced a series of geological maps based upon this principle. Since his day, great progress has been made in classifying the sedimentary rocks and zoning them according to their fossil remains.

If it is desired to make a collection of fossils and minerals it is essential to have a geological map to enable one to discover what formations there are and where they may be found. The geological sketch map reproduced in page 413 gives a fair representation of the distribution of igneous and sedimentary rocks throughout the British Isles, and the table of strata in page 416 shows how the rocks are



British Museum (Natural History)

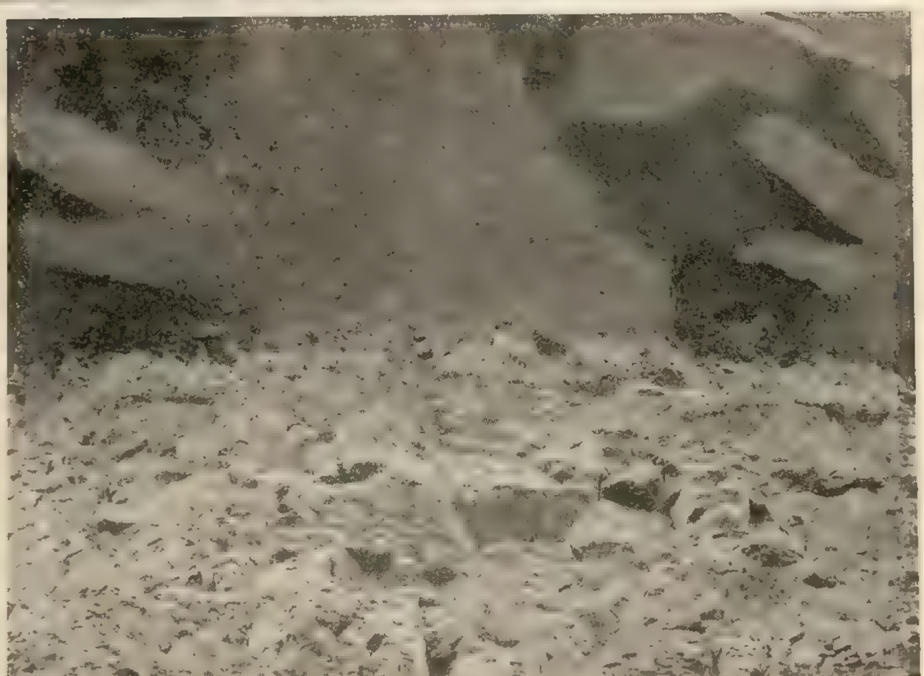
PRIMEVAL FERN

Plants as well as animals are found in a fossilized form. This photograph shows a plant from the Radstock group of the upper coal measures near Radstock, Somerset. The beautiful preservation of this specimen is noteworthy and gives a very good idea of the type of flora that existed in the Carboniferous period.

F. Martin Duncan

PETRIFIED TREES

In fossilized vegetation we find not only leaves and fronds, but also whole tree trunks. In this photograph we see the hollow prostrate boles of two trees now exposed in the cliff at Lulworth. Fossil trees are also not uncommon hidden deep in coal seams.



H. E. Taylor

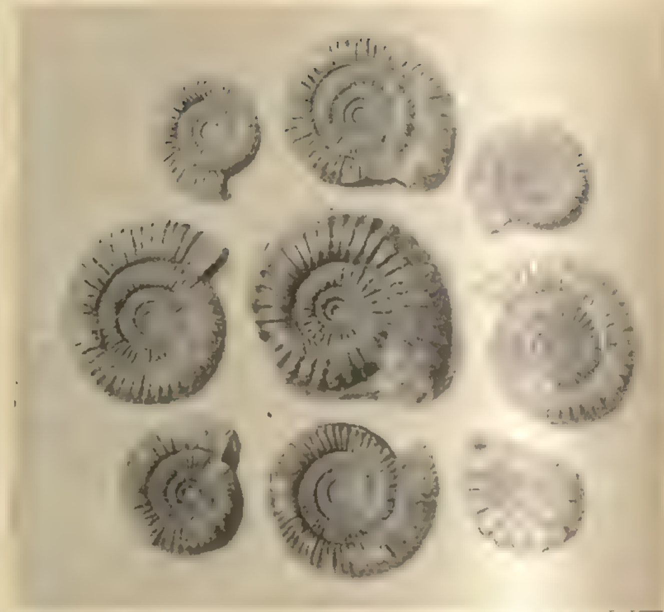
FOOTPRINTS IN STONE

This photograph shows a rare discovery—the footprints of a bipedal dinosaur preserved in sandstone near Scarborough. The two footprints may be seen at the top of the photograph on the underside of a slab of rock. The centre one of the three toes measures 25 in. and the length of the double stride was 10 ft. 8 in.

classified. An examination of the map will show that the newest sediments are found towards the south and east of England, while they become progressively older towards the north and west, the main igneous rocks being also situated towards the north and west.

The sedimentary rocks are divided up into the four chief divisions of *Archaean*, *Palaeozoic*, *Mesozoic* and *Cainozoic* or *Tertiary*. Between all of these chief divisions there are large gaps in time, as shown by the break in the sequence of fossils. Traced upwards through the strata, the fossils, beginning with low forms of life in the *Cambrian*, become progressively higher in the evolutionary scale until they end with relics of Man in the most recent deposits.

For the collector of fossils the *Jurassic* and *Cretaceous* divisions of the Mesozoic rocks offer the most fruitful fields. A visit to the *Gault* clay at Folkestone or to the *Liassic* shales and limestones at Lyme Regis in Dorset or Whitby in Yorkshire will yield a rich harvest of these "records of the past." But if anyone wishes to collect seriously or to understand fully the district in which he lives, he should buy a geological map of the larger scale of six inches to the mile. Then, on ramble or tour, the formation that makes up each hill and valley may be traced and its special characteristics noted, so that the student will gain that practical experience that is worth far more than theoretical study. By learning beforehand the fossils that are



V Waters

COMMONEST OF FOSSILS

Ammonites are the commonest of our British fossils. These coiled shells are so plentiful in the Jurassic rocks that the strata are zoned according to the different species occurring in them. They may vary in size from tiny specimens to large shells measuring several feet in diameter

to be found in the different formations the student will have some idea of what he may discover when he visits cliff or quarry with hammer and collecting bag.

It is only occasionally that fossils have a direct effect upon the appearance of any locality, but it so happens that beds of rock are formed from the accumulation of oyster shells, and such fossil beds may be seen as platforms on our seashores, or projecting as hard bands in the cliff face. Again, one may see the bole of a large, long petrified tree which may stand up both as a landmark on the cliff or rock face and a pointer to the past. Conversely, however, one may guess the nature of the fossils from a glance at the landscape, once we are sufficiently experienced. The landscape near Lyme Regis is typical of the Lias formations which hold the bones of extinct reptiles and the coiled shells known as ammonites. Again, the downs are typical of the chalk, and the enthusiastic fossil collector will soon learn that in chalk cliffs and quarries he may collect the shells of long-extinct sea-urchins. When the association of rock and fossil has been learned, a study of the landscape will give the palaeontologist a rough guide to those localities where he may add to his collection.

TELLING THE AGE OF THE ROCKS

In order to understand the full sequence of the sedimentary rocks it is necessary to study a stratigraphical table such as is given herewith. In this table, the chief systems and their major subdivisions are listed, and although such an array of names may appear formidable, they are not difficult to learn, studied in conjunction with the geological map in page 413.

QUATERNARY

Alluvial and Recent. Pleistocene.

CAINOZOIC OR TERTIARY

Pliocene. Miocene. Oligocene. Eocene.

MESOZOIC

Cretaceous
Chalk. Upper Greensand and Gault. Lower Greensand. Wealden.
Jurassic
Oolitic. Liassic.
Triassic
Keuper Mud. Bunter Sandstone.

PALAEOZOIC

Permian
Magnesian Limestone. Red Sandstone.
Carboniferous
Coal Measures. Millstone Grit. Carboniferous Limestone.
Devonian
Upper and Lower Old Red Sandstone.
Silurian
Ordovician
Cambrian

ARCHAEAN OR PRE-CAMBRIAN

Gneiss. Schist. Torridonian Sandstone, etc.

It will be seen that there are five main divisions: the Archaean, Palaeozoic, Mesozoic, Tertiary, and Quaternary. Of these five, the Archaean rocks are practically confined to the north-west Highlands of Scotland, the Quaternary consist only of recent alluvial and peat deposits (except for boulder clay, which is a superficial deposit of general distribution), and the Tertiary, as may be seen in the map, are found mainly in south-east England. It is clear, therefore, that the Palaeozoic and Mesozoic rocks form the bulk of our island. These rocks consist of limestones, sandstones, slates, clays and all the other varieties of sedimentary rock, the only essential difference between the two great divisions being one of age, the Palaeozoic rocks having undergone a certain amount of alteration through earth movement and igneous intrusion.

There is only one certain way of telling the age of a rock and that is to examine the fossils it contains, for fossils are used for zoning and grading the strata. Thus in the Cambrian, Ordovician and Silurian rocks, the fossils are of a lowly nature, such as graptolites, which are related to the present-day hydrozoa; and brachiopods, represented by primitive shellfish alive today; and trilobites, which were primitive crustacea. In the Devonian era are found the first fishes, to be succeeded by the first reptiles in the Permian. The Mesozoic era is sometimes known as the age of reptiles, though the first mammals are found as low down as the Liassic. To the fossil hunter, the Mesozoic rocks form the most fruitful hunting grounds; molluscs and other shells abound; particularly plentiful are the coiled shells known as ammonites, and every visitor who has been to either Lyme Regis in Dorset or Whitby in Yorkshire must be familiar with these attractive fossils. The giant reptiles and the ammonites died out at the close of the Mesozoic. The Tertiary era is essentially modern in the character of its fauna; living forms or those nearly related to living forms abound, and the mammals succeed to the reptiles as the dominating group in the animal world. The Quaternary is sometimes included within the Cainozoic period and sometimes regarded as a separate division. It is the most recent of all the geological periods, and includes the Pleistocene formations, *e.g.* the boulder clay and all the subsequent alluvial deposits

Impossibility of Dating

It must not be thought that these divisions represent equivalent periods of time, for they are based on palaeontological evidence, not on a time duration basis. Thus the Quaternary period forms an infinitesimal fraction of the whole, the Palaeozoic is much greater than the Mesozoic, and the time duration of the Archaean is unknown, but was certainly immense. Moreover, we cannot say how long ago any particular stratum was deposited.

BENEATH THE SURFACE WITH THE WATER SPIDER

NEARLY two hundred years ago a Belgian priest, bathing in a stream near Ghent, discovered the existence of the water spider, and ever since this extraordinary little creature has aroused the interest and admiration of succeeding generations of Nature-students. The ingenious way in which this air-breathing spider manages to spend a large part of its life under water is told and illustrated below

As the sea was the birthplace of life, all animals, even the highest of terrestrial forms, are descended from animals originally aquatic. But life on land was not always easy to sustain, and in the struggle for existence certain forms took to the water and became secondarily adapted to an aquatic environment. Sometimes these animals, such as the seal, were highly developed and had many millions of years of land-living

J. J. Ward

HAIRY DIVER

The male water spider (above) is about 16 mm. long, as compared with the female's 11 mm. The vital hairs which cover its legs and body are used to entangle the bubbles of air which the spider pulls below the surface in order to provide itself with the oxygen essential to its life.

ancestors behind them. Other animals, such as the water spider, are more nearly related to the original marine forms and probably had less difficulty in changing to an aquatic life even if their medium was freshwater and not marine.

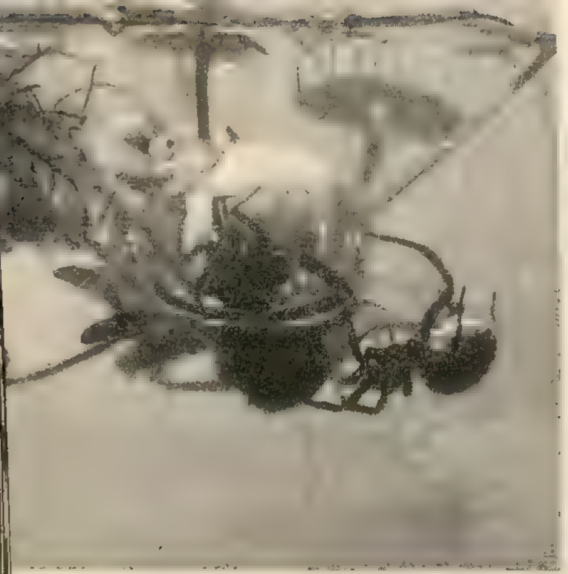
The near aquatic ancestry of the land-living spiders is suggested by a study of the development of the scorpion, which is only another kind of spider. Among the many animals which are classified as arachnids is the king-crab, or *Limulus*. This seawater organism is provided with a number of appendages known as gill-books, which are used as gills, and are composed of a chitinous substance through which the circulating blood is able to come into close contact with the oxygenated water. It is found that, in the very early developmental stages of the immature scorpion, there exists for a time a series of gill-books exactly analogous to those of the king-crab. Thus a fascinating light is thrown on the evolution of the spider, for we are led to the conclusion that scorpions, and therefore spiders, have evolved from seawater-living organisms similar to the king-crab. This argument becomes particularly important in the consideration of the water spider, which by a number of complicated forms of adaptation has been able to return to the habitat of its forefathers, although it has confined itself to the freshwater ponds and streams.

Spiders are certainly amongst the most enterprising of animals; by means of their silken secretions they have

UNDERWATER SEARCH

The water spider below is crawling about under water in search of a piece of weed on which to build a nest. The bare bottom of the stream is not the best of places for a water spider to seek a home, and it is more than likely that it will have to go to the surface for more air before the search is completed.

H. T. Roberts



ARDENT MALE

Inside the nest seen above, built just below the surface of the water, resides the female water spider. The male, approaching the nest, endeavours to enter and court the female, but, as is seen below, is eventually repulsed.

ADAMANT FEMALE

Even the possibility of being eaten alive does not deter the valiant little male from continuing the courtship. Going to the top of the nest, he rocks it backwards and forwards to attract the attention of the female (below).

not only been able to distribute themselves over the entire surface of the earth (except some parts of the Arctic and Antarctic) and managed to go sailing through the air on their gossamer threads, but have also dived under the water to subaqueous nests. The pirate spider (*Lycosa piratica*), for instance, is a species which is neither fully aquatic nor completely land-living. It has greasy and very hairy legs, while the body is also covered with numerous small hairs which keep it dry. When the spider walks on the water it does not sink, its light weight merely indenting the surface film, or "meniscus." It can, however, break through this film and dive beneath the surface.

If at all alarmed, it will immediately do so, and, swimming by means of its eight legs, grasp the leaf or stem of an aquatic plant and remains hidden until the danger has passed. But how does it breathe? Supplied only with lung-books and no form of gills, the water spider finds it necessary to carry its air below the surface in bundles of bubbles which adhere to the hairs of its body. These bubbles of life-giving air are so arranged that, under the water, the lung-books are able to tap them for oxygen when this proves necessary. The female of this species carries as many as one hundred eggs in her silken egg-bag. Although she spends much of her time on the surface of the water or on dry land, she is just as active as the male in diving below the surface and in taking with her the necessary supplies of air.

Another genus of spiders which spend their lives in the water are the *Dolomedes*, one species of which, known as the raft spider (*D. fimbriatus*), adopts very different tactics from those employed by the pirate spider, for it fastens a number of leaves together with silken threads to form a raft, and on this structure it is able to float about on the surface of the pond, until, seeing an unwary insect, it springs overboard, and, walking

BATTLE JOINED

After the male water spider seen in the series of photographs on the left has departed, there approaches another female (above), who endeavours to appropriate the nest. She takes the door (photograph below) and attacks the female within.

Photos, J. J. Ward

SUCCESSFUL DEFENCE

But the inhabitant of the nest is not to be overcome by a mere female, when she has already beaten off a determined male. Plunging out of the air bubble, she drives her rival away (below) and eventually retires triumphant into her fortress

over the surface of the water, pounces upon its prey. The insect is then hauled back to the drifting raft and devoured at leisure.

Many of the spider race, unable to adapt themselves to a semi-aquatic existence, have gone even further than the two species described above, and have taken to the water as their one and only home. Such are true water spiders, which belong to the genus *Argyronetae*—a word taken from the Greek meaning "silver spindle." The spindle-shaped bodies of these spiders and their silvery appearance when diving, caused by the bubbles of air clinging to their hairs, make the name an apt one. The true water spider is to be found solely in rivers and ponds where there is either only a very slow current or no current at all. It makes for itself an underwater silken balloon filled with air, and in this it lives, breeds, lays its eggs, and brings up its young.

Filling the Nest with Air

In building its nest the water spider displays extraordinary agility and cleverness. The foundations of the nest are bubbles of air, and these it hauls below the surface and fastens in position by means of silken threads, which are eventually woven into a more solid covering. The method by which this is done is as follows.

Just before building its nest, the spider attaches a number of threads as mooring lines to a suitable piece of weed some distance below the surface. The little animal then swims upwards, paying out the threads as it goes, until it reaches the air. It next turns over on its back, and by means of waving its eight legs in the air, shakes itself completely free from water and soon becomes quite dry. Once it is in this condition, the air clings in large bubbles to the long hairs on its body, and before the bubbles have time to burst it dives suddenly to the site of the nest, carrying them with it.

By means of the mooring cables it is able to pull itself downwards, in spite of the air tending to force it up to the surface, and on reaching the selected piece of weed it hauls in the cables and uses them to tie the bubbles in position. If a particularly large bubble is taken down, the hind legs are often utilized in holding it in position until sufficient silk can be secreted to cover it up and tie it down. As soon as enough air has been obtained the spider proceeds with the construction of the nest proper, and a great deal of weaving, cross-weaving and tying has to be done before this is complete. When finished it consists of a little tent of silk fastened in position on the leaf of a water weed, and has the appearance of a glistening, underwater bell.

The courtship of the female water spider by the male is somewhat similar to that of the garden spider described

AIR-CHARGING THE NEST

Although the water spider breathes air it passes most of its life under water, making use of the oxygen in the bubbles of air which cling to the hairs on its body and legs. In this series of photographs we see the process of re-filling the nest with air bubbles hauled from the surface and held by the back legs.

J. J. Ward

F. H. Bond

AT HOME IN A BUBBLE

In the upper of these two pictures the water spider is seen curled up inside the bubble of air held in position on a blade of grass below the surface by fine threads of silk. In the lower, the spider can be seen leaving its little home, the manner in which the bubble clings to the creature's body being clearly apparent.

in page 304. The male first covers his body with tiny bubbles of air, which keep him supplied with oxygen until he is able to enter the house of the lady of his choice. Meanwhile, the female is hiding inside the nest and awaiting his attentions, but he keeps well outside and approaches only with the greatest caution. Amongst the water-weeds around the nest the female has laid down a large number of silken cords, and these the male uses to signal his intentions. At first she pays little or no attention, but after he has been twitching the cords for several minutes she comes out of the trap-door and drives him away with a threatening gesture. The male shows no courage—he turns tail and bolts; and, indeed, if he did not do so he would be in danger of his life, for the female, if she caught him, would not hesitate to haul him indoors and devour him alive.

Birth and Breeding Inside the Bubble

In time, after repeatedly "ringing at the front door" by means of the silken bell-pulls, the male is at last able to gain an entrance without danger to himself, and, once he is inside, the actual process of mating takes place. The eggs are laid by the female and stuck on to the roof of the nest in order to keep them clear of the water, and it is inside the nest that the entire process of bringing up the young family is carried out. The offspring, though they breathe air like their parents, are not at first provided with the necessary hairs; the mother spider is, therefore, obliged to keep them inside the nest until their bodies become covered with the velvety pile of hairs which later make them proof against the water.

With the coming of winter the water spiders go down into the deepest parts of the pond and build tiny cells of air, in which they live throughout the colder months. The water at the bottom of a pond rarely freezes, its temperature remaining constant at about 4° C. (39·2° F.), which is just above the lowest temperature at which the water spider is able to survive.

At this temperature much of the life of the pond is in a state of semi-hibernation, and during the frosty weather the majority of aquatic organisms become so lowered in their vitality that they sink to the lower levels of the water and go to sleep.

Revealers of Nature. 13

MAURICE MAETERLINCK

The study of Nature is often embarked upon for two entirely opposite reasons. The first, which is responsible for most students being attracted to it, is the hope of obtaining from it fresh evidence concerning the story of mankind; human life and affairs are the main interest—Nature-study possesses its chief value in the light it may throw on the development of Man and his customs. But another party of observers—among whom are mostly figures more literary than scientific—find in Nature a world entirely apart from the life around them. Disgusted or disappointed with existing conditions in Man's life, they turn away from it to find solace in a natural existence where there is no morality and consequently no vice, no violent political and social upheavals, no questioning of authority, no torturing doubt or oppressive dictatorship; they love Nature because she is so different from, and not because she is so similar to, Man, from whom, in her, they find a welcome avenue of escape.

Among the latter party was the famous Belgian writer and mystic, Maurice Maeterlinck. Even in his plays, poems and essays on subjects that have no connexion with Natural History he was apart from Man; the adventures of his characters, who, though they are human figures, are vague, shadowy beings—knights of chivalry, desolate orphans, blind wanderers—are adventures of the spirit. It is consistent, therefore, that, having turned away from concrete human life to a nebulous, spiritual existence in his early works, he turned still further away in his later books to a life wherein Man plays no part at all—the life of Nature, and, particularly, the self-contained, ordered life of the social insects. Thus Maeterlinck's famous "The Life of the Bee," for instance, is not a side-line, but an integral part of his literary development.

Maurice Maeterlinck was born, on August 29, 1862, at Ghent, where from his youth he mainly resided. He was never anything but a writer, and, as a writer, hardly anything but a mystic. Beginning with a volume of symbolist poems, he made his reputation first with *Pelléas et Mélisande*, a play that was published in 1892, and with a series of plays for marionettes. After further volumes of verse, essays and drama, his work on bees, *La Vie des Abeilles*, appeared in 1909. This, apart from his ever-popular fantasy, "The Blue Bird," which came out in 1910, is probably the work that is most widely read in England. In it Maeterlinck combined a fanciful imagination, his own mystical philosophy, and an unexpected carefulness and patience in the observation of insects. He cannot by any means be dubbed an entomologist; yet his work on bees has probably been responsible for a greater stimulus to popular interest in that subject than all the entomological treatises and text-books ever published. The same is true of his other works on insects: *La Vie des Termites* (life of termites, or white ants); *La Vie des Fourmis* (life of ants); and *L'Araignée de Cristal* (the water spider). All these works have been translated into English—the last-named forming part of "Pigeons and Spiders," 1935, in which Maeterlinck's work on pigeons was also incorporated.

These are literary as well as, or perhaps more than, scientific studies, but they constitute for the beginner in Nature-study an excellent introduction to the study of social insects; the style is exquisitely fanciful—an uncommon feature in works on entomology—and the author had no axe to grind and no theory to propound. He died at Nice, May 6, 1949.

LURID EPISODES IN THE CUCKOO'S CAREER

THE ways of the cuckoo are sufficiently strange to attract the attention of every Nature-lover, and though they have often been described and are, perhaps, generally known —at least, in broad outline—their story well bears retelling. Here, then, we read of the cuckoo in the nest, and of the sad fate that befalls the fledgelings that are so unfortunate as to be born into the same home

FEW birds have attained to such fame, or some would say to such notoriety, as the cuckoo. Welcomed on account of its joyous notes in springtime, it soon suffers a loss of prestige when we forget the pleasure of its first arrival and remember only its usurpation of the nests of smaller birds and the murderous career of the usurper's young. Nevertheless, it almost goes without saying that the first time we hear the call, "cuc-koo, cuc-koo," ringing through the woods, we feel that spring is really here at last, and summer not so very far away. And we are, moreover, usually justified in this assumption, for, unlike many other so-called harbingers of spring, the cuckoo is seldom premature. The March cuckoo, it has been said, appears first "in the newspapers," and although there is little doubt that the bird may arrive in March, April is certainly well on its way before the familiar call is heard in most parts of the country.

It is, of course, this song that has given the cuckoo its name—and "cuckoo" is, indeed, the only word that can sum up the bird's song —but it has other notes less well known but no less characteristic. The female bird is usually credited with the curious sound that is best described as the "water-bubbling" cry, and there is also a harsh alarm note. The water-bubbling notes of the cuckoo appear to be used as a mating call by the female bird, for there is always a superabundance of males who come, several at a time, to compete for the female's favour when she "bubbles." There is, however, a certain amount of evidence to show that either of the two series of notes may be used by both sexes, and no absolutely definite rule can be laid down.

THE question of the cuckoo's nesting, or, rather, egg-laying habits has been the cause of more controversy than perhaps any other point with regard to the habits of any one bird. In spite of the extent of our knowledge on this subject, there is still no exact rule formulated as to whether the cuckoo always follows any one procedure. There is support, for instance, for the theories that the bird selects a nest beforehand and then lays its eggs therein, and also that it lays the egg on the ground and carries it in its beak to the nest and places it therein. Further evidence shows that two eggs may be laid in the same nest, but whether by one bird or by two different birds is not known; that one cuckoo can lay only one type of egg, which may be similar to those of one of the birds in whose nests it lays, but not to those of any of the other birds; and that the cuckoo may confine its attentions to one species, or, on the other hand, may choose the nests of a number of quite unrelated species.

All these are points on which there is room for argument, but doubt does not end here. The behaviour of the young cuckoo when it has hatched from the egg has also been the subject of much painstaking research on the part of a large number of competent observers. As a

DISTINCTLY PERSONABLE

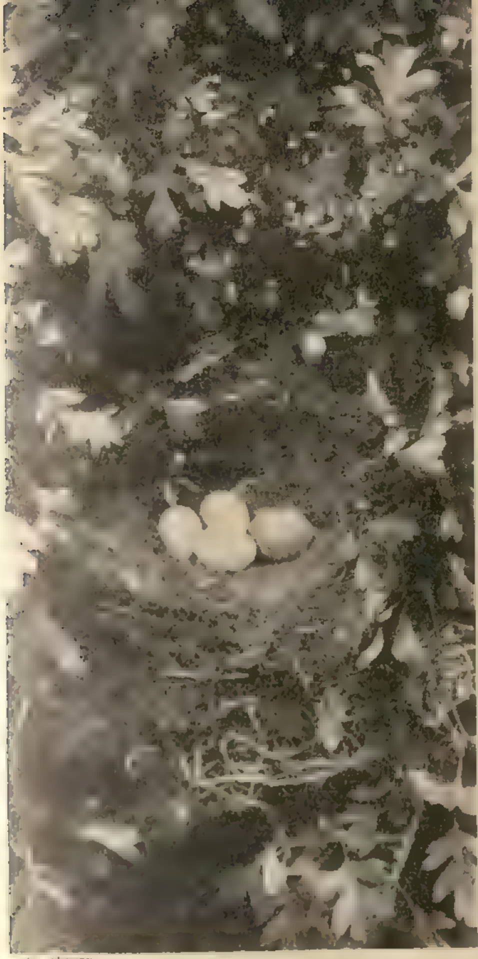
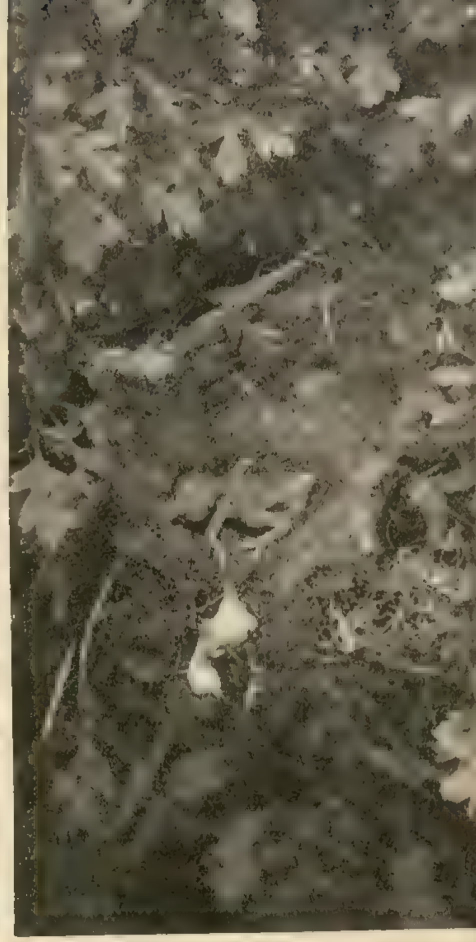
The adult cuckoo is a very fine bird, and has much in its build that reminds us of the hawk. The long tail, greyish colour, and, in particular, the wings, are responsible for many mistaken identities; and the alleged March cuckoo is usually a hawk, when it is seen, or a small boy, when it is heard.

O. G. Pike

G. Bird

EJECTING THE EGG

In the series of photographs in this page we see the newly-hatched cuckoo in the act of perpetrating one of the crimes with which it usually begins its career. In the first picture, one of the eggs of the foster parent is still left in the nest, and the young cuckoo appears to have just felt this egg with the soft, sensitive portion of its back. In the next picture (centre, above) it has wriggled its [illegible] under the egg, which now lies in the middle of its back. The third picture shows the way in which the wings, featherless as [illegible] used to push the egg up the back. The two pictures below, taken from the back and the front at almost the same time, sh[illegible] final stage. The bird has raised itself on its wings, and also, as the pictures reveal, on its legs. It will be seen that the camera [illegible] clicked when the egg is on the verge of the nest, just about to fall to destruction over the edge

G. Hearn

MURDER MOST FOUL

A cuckoo's egg, easily distinguishable by its greater size and darker colour, lies in a hedge sparrow's nest beside three eggs of its foster parent (left, above). In the next picture a very different situation is revealed; the eggs have all hatched, and the young cuckoo is about to eject the last of the nestling hedge sparrows. In this case, the usurper has hatched later than the lawful occupants of the nest, whereas in the series of photographs shown opposite, they are hurled to destruction before they emerge from the egg. The right-hand picture shows the young cuckoo, exhausted by its efforts, while the wretched victim hangs lifeless over the edge. Despite the murder of its offspring, however, the hedge sparrow continues to feed the little ruffian, which, as the left-hand picture below shows, soon grows larger than its foster parent. The young bird is insatiable, and at the first sign of the hedge sparrow's return clamours to be fed.

A. H. Willford

LUSTY BABIES

One cuckoo in the nest would seem more than enough for a pair of birds, but this meadow pipit apparently has two cuckoos under its wing—speaking metaphorically, for here it seems to be perched on the back of one of them. The foster parents must be hard put to it to satisfy the greed of two children of such inconvenient size.

result of all this work, what can we say with any degree of certainty?

To begin with, there is the evidence of a number of cinematograph films—those, for instance, of Messrs. Edgar Chance and Oliver Pike, in which the cuckoo is seen laying her egg in the nest of the victim, usually a small bird such as a meadow pipit or reed warbler or pied wagtail. Before laying her egg she appears to remove one of those that are already in the nest, and to hold it in her beak while she lays her own. She is then said to swallow or eat the egg, and it is certain that an egg is normally removed to make room for the egg which she lays in the nest. Again, Lord Grey records that he found a solitary cuckoo's egg in a nest on which a sedge warbler was sitting. Since the latter bird would not have been sitting unless she had herself laid a clutch of eggs, there seems no alternative to the conclusion that the cuckoo had removed all the sedge warbler's eggs.

To many people the atrocious character of the adult cuckoo's performance might seem infamy enough for one bird, but the adult is innocent compared with the young bird. This little monster hatches from the egg in a shorter time than is taken by most birds, about thirteen days after the laying of the egg. When it is two days old the young cuckoo begins its disgraceful career. In the nest there are normally a number of either the eggs or the young of the foster parents, and these the villainous infant proceeds to eject.

What Makes the Cuckoo a Murderer?

THE theory was advanced by W. H. Hudson that the skin of the young cuckoo's back is especially sensitive, and consequently, as soon as it feels anything pressing on this skin, the bird has to get rid of it. The means by which this is done was described by Jenner, the inventor of vaccination, as long ago as the end of the 18th century, but for many years his observations were regarded as fiction. As soon as the young bird feels anything touching its back it sinks to the bottom of the nest, so that the

G. Hearn

GREEDY INGRATITUDE

This photograph, which carries on the series contained in page 423, shows the almost fully-grown young cuckoo, now ready to fly, sitting on the remains of what was once a hedge sparrow's neat little nest, and calling greedily for yet more food.

F. Jefferson

FEEDING THE INTRUDER

Perched on a branch, the young cuckoo is fed by its hedge sparrow foster parent, who places the food well down the hungry youngster's throat—perhaps to make sure that it is received, but more probably because the little monster is too stupid, perhaps too lazy, to take anything for itself.

EVER-OPEN MOUTH

Having just had a large mouthful of food, the young cuckoo expresses its gratitude by screaming petulantly for more, although the fact that the hedge sparrow's bill is empty might tell it that there must be a pause before the next course is forthcoming.

F. Jefferson

C. W. Teager

GROWN UP

This young cuckoo seems to be capable of "standing on its own feet" at last, after the long period during which it has taxed all the powers of its foster parents to keep pace with its enormous appetite. Hereafter, it will be quite a useful member of the community, for adult cuckoos are good friends of the farmer, making away with many harmful insects.

irritating object rolls on to its back. When the egg, or other young bird, is firmly on the young cuckoo's back, the latter exerts all its force to raise itself on its legs, so that the object is lifted to the level of the edge of the nest. The stumps that will later grow into the wings are then also brought into play, being used almost as hands, to raise the cuckoo still farther, until the offending object is pushed right over the edge of the nest to destruction. If the object remains on the edge of the nest, although well out of the cuckoo's way, the murderer is not satisfied; the victim must be removed from the confines of the nest before the villain proceeds to repeat the process with other eggs or young.

Whether two young cuckoos will try to eject each other has apparently not been discovered, but a pair of the birds has certainly been reared by one pair of foster parents. As an example of the apparently hypnotic power that the young changeling exerts over its foster parents, one observer has brought forward the instance of a young cuckoo that threw out all the young of a redstart while the mother bird was brooding on the nest!

Unhappy Lot of the Foster Parents

YOUNG cuckoos grow apace, and the foster parents are often hard put to it to keep up with their protégé's enormous demands. But they seem quite as incapable of hurting the cuckoo as the latter is of showing any gratitude, for its thanks are usually expressed by means of a vicious peck at the birds that are spending their lives in bringing up the murderer of their own children.

When full-grown the cuckoo is a handsome bird. In appearance it is very similar to a hawk, and when at rest it is probably often mistaken for a sparrow-hawk. On the wing, however, its long, narrow wings betray it. The colour of the upper parts is slate grey, with white bars and tips to the outer feathers of the tail, and white spots on some of the wing quills. Beneath, white barred with grey is the general colour scheme, the grey of the back extending all over the head, chin, throat, neck, and the upper part of the breast.

Though the date of its arrival is a controversial matter, there is no doubt about the time of the cuckoo's departure: the birds leave from August onwards, the adults going first, the young often being still in England in October.

Only one good thing, it would seem, can be said of the cuckoo: it is one of the farmer's best friends, for its diet consists almost entirely of insects, and it is especially fond of caterpillars. It will even eat those large, hairy caterpillars known as woolly bears, as well as many other hairy or distasteful larvae that no other birds will touch.

The cuckoo is a member of the order *Cuculiformes* (Latin *cuculus*, the cuckoo). It is separated from the Passerine birds by its having what is known as a zygo-dactyl foot, i.e., one in which the toes are two and two, in contradistinction to the Passerine foot in which there is only one hind toe. Apart from this, however, there is much in the bird that resembles the typical Passerine, as well as much that reminds us of the hawks. It should be noted that not all members of the cuckoo group are parasitic on other birds. Some species, such as the yellow-billed cuckoo, a North American form that sometimes strays to the British Isles, build their own nests and incubate their own eggs in the normal way.

HINTS ON OBSERVING CUCKOOS

Since the subject of what the cuckoo does and does not do has been the matter of much controversy, and since that controversy has been of the most acrimonious type, everyone who makes any observations on this bird should take very great care that he notes only what has actually been seen. If, for instance, the cuckoo is caught at the nest carrying an egg in its beak, it should not be taken for granted that this is either its own egg or that of the bird whose nest it is visiting. A note merely to the effect that the bird was holding *an* egg, *either* that of the foster parent *or* its own, should be entered up if there is the slightest room for doubt.

The problem of how to find the cuckoo's egg is one that will puzzle the beginner. Occasionally the cuckoo may be seen flying away from a bush or patch of ground, and the nest containing the egg may then be located. In such a case as this the presence of the owners of the nest, flying round with anxious cries, may help to reveal the nest's situation. Once the egg has been found, the nest should be visited fairly frequently, unless it is known on what day the egg was laid, in which case there is no need to visit it until the day of hatching approaches.

The presence of cuckoos in a district means, of course, that somewhere there will be eggs or young birds. One good plan is to hunt especially for the nests of those birds, such as hedge sparrows, pipits, wagtails, or warblers, which the cuckoo is most fond of parasitizing. If the ground is covered properly, a cuckoo's egg should be discovered sooner or later, and we can then be prepared to settle down to watching.

DAISIES AND DANDELIONS IN A VERDANT FRAME

Perhaps the best-known of all the wild flowers of our countryside is the common daisy, described in the chapter that follows, together with the exceedingly common and almost equally well-known dandelion. One and the other are among the first flowers to enter into a child's consciousness, and possibly this is why their homely beauty never seems to fail in its appeal

To say that any particular flower or bird or insect is known to everyone is perhaps a rather rash statement, but if there is any one flower to which it can be applied with a large measure of truth, surely the daisy is the one that would most merit the honour. At first sight, it seems to have few claims to our attention, for it is remarkable neither for beauty, nor for rarity, nor for grace, nor, in fact, for any of the features that have made many of our other flowers familiar and famous. In some way or other, however—perhaps on account of the smiling appearance of its flowers sprinkling the green meadow grass with stars, perhaps because it is the happy sign that summer is here at last—the daisy has won a permanent place in the hearts of men.

To the casual passer-by or to one who knows a little botany but has never been sufficiently interested to examine the flowers closely, there may seem nothing out of the ordinary in the daisy's bloom. A ring of white petals, they would say, below which is a generous array of dark green sepals, with a yellow centre that must be made of the stamens. But the botanist knows better: the bloom of the daisy is not one flower but many, and the parts which the tiro mistakes for petals are themselves tiny flowers. This feature is characteristic of the *Compositae*, one of the largest and most important orders of the whole vegetable kingdom. Composite flowers, as they are called, are marked by several of the features outlined below, although it must be borne in mind that not all composites have all these features.

OPEN AND SHUT

The daisy, like many other flowers, is very susceptible to sunlight, and on bright days, or during sunny spells on those that are generally dull, its flower-heads open wide, as shown in the photograph above. In the evening, on the other hand, or when the sky is overcast, the ray florets close in and the flower shuts itself up.

The flowers are always small and are collected together on the receptacle, that is, the enlarged top of the flower-stalk. They are surrounded by an involucre of bracts, which are the bodies that, as already mentioned, appear to be the sepals of the daisy. The florets themselves are of two kinds, known respectively as tube or disk florets and ray florets. These, in the daisy, are exemplified by the apparent stamens, or yellow centre (disk floret), and the apparent petals (ray floret). Each floret consists of a corolla, either tubular or strap-shaped, according to the type of floret; four or five stamens, whose anthers are often combined to form a tube; and a single-celled ovary, surmounted by a style, which may split at the top into two arms, which are the stigmas. The calyx is represented in the individual floret by a body that is normally situated at the top of the ovary. It is not seen until the fruiting stage is reached, when it consists of

DANDELION DEVELOPMENT

In this one picture can be seen the history of the dandelion blooms from the oblong bud, with its radiating bracts (in foreground), to the opened flower-heads, and (centre) the final mass of the seeding head. The flowers, composed entirely of ray or strap florets, are a composite type differing somewhat from that of the daisy, seen in the preceding page.

hairs or scales, being chiefly visible as a winged organ by which the seed is spread; this is the down of the dandelions and thistles, botanically called pappus.

The above general description will be found sufficient as a basis when examining any composite flower, and whenever in this series a composite flower is under discussion the type of inflorescence is fully described.

It is clear that the daisy affords us an example of a composite flower in which there are present all the parts to which we have referred. It possesses some 250 florets, the greater part of which are of the tubular or disk type, being arranged in concentric rings to form the yellow centre of the flower-head. The ray florets are incomplete, having only a pistil and no stamens, whereas the disk florets are equipped with organs of both types.

Botanical Details of the Daisy

Well worth studying is the development of the daisy. The stamens of the disk floret are arranged in such a way that all the anthers come together at the top of the tube, thus forming a little chamber. The anthers mature long before the stigmas ripen, and shed their pollen into this chamber. The style, which grows up the middle of the chamber bearing the immature stigmas, then elongates, forcing its way out between the anthers, and, at the same time, pushing the pollen out before it, so that it lies in a mass on the surface of the flower. The pollen is then picked up on the legs or bodies of the insects that come to seek nectar in the flower. When this has taken place, the style elongates still further, and splits at its top to expose the stigmatic surfaces, which are themselves now ready to receive pollen brought by insects that have come from other flowers. There is also, in the case of the daisy, a further adaptation to ensure adequate fertilization, for at night the ray florets close over the central disk as though to guard it from the cold and dew, and their stigmas then come into contact with the exposed pollen of the disk florets, thus giving rise to self-fertilization.

How the Daisy Attracts the Insects

The florets of the disk always open in a special and definite order, and this is a matter of importance to the daisy. Examination of a daisy that has not been in bloom for very long will show us how this happens. The outer rows open first, in strict order, so that, when the stigmas are showing on the outermost row next to the ray florets, and the masses of pollen are visible on the row inside that, the innermost florets still appear as little more than balls of yellow corolla. There is a logical explanation of the arrangement of these two kinds of florets. It has been discovered that insects are attracted only by certain colours; white is not one of these, but yellow is one of the most attractive. Now, in the daisy, there is not sufficient yellow to attract the insects when other and brighter flowers are competing near by, and another scheme has to be employed to lure the insects. There are several alternative schemes, but the daisy adopts that of contrast; with its white rays surrounding a solid yellow centre, it provides a strong contrast in shade and pattern, and this is probably as effective as the pure yellow colour would be

A further point that has been discovered with regard to the attraction of insects is that the contour of the flower is of great importance. Thus the ratio of the length of the edge of the petal to its area in many cases controls the value of the flower for purposes of attraction. The daisy uses this fact also, since its many narrow florets, by having a very large contour in comparison with their area, increase the flower's attractions. An even better example is afforded by the stitchworts, described in page 162. These are pure white flowers; their colour is of no value, nor do they show any contrast. The five petals, however, are long, narrow and separated, and, in addition, are deeply cleft; this increases the contour enormously—especially in the case of the lesser stitchwort, in which the cleft is very deep—without altering the surface area of the petal, and thus compensates for the negative value of the plant's colourlessness.

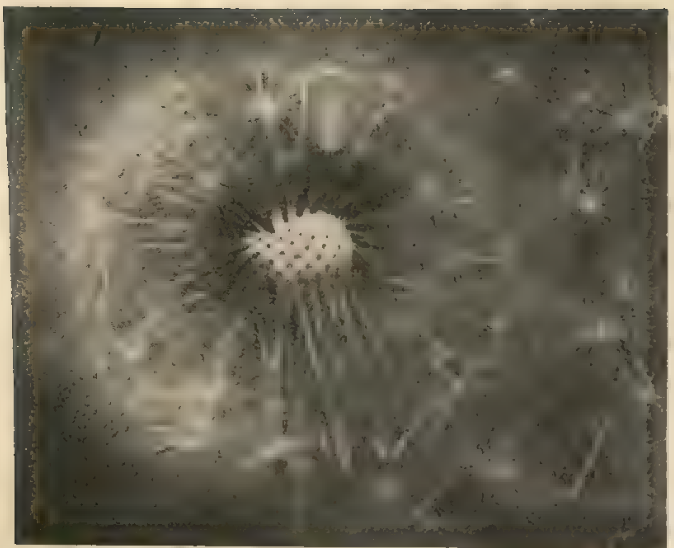
Several other features of interest are to be discovered in the daisy plant. Its leaves, for instance, are all radical, and are spatulate, having slightly serrated edges. The scapes, as the stalks of a composite flower are properly termed, arise from the middle of the rosette formed by these leaves, and vary in height from two to five or six inches. The manner in which the leaves form a rosette is another instance of the pertinacity of the daisy, for

DAISIED GRASS

One may often see [illegible] fields made white with [illegible], but seldom do the [illegible] flowers appear in such profusion as is seen in the photograph above. The wide-open, upturned heads are indicative of the continuance of fine weather.

READY TO FLY AWAY

Below: this wonderful array of seeding dandelions may be attractive in the eyes of the rambler, and delight the country children, whose "clocks" they are, but they mean bad luck to the farmer whose soil is destined to receive the seeds.



H. Bastin

TAKING FLIGHT

Here we see a dandelion head photographed just as the seeds, each borne by a little umbrella-shaped mass of pappus, or down, are being driven by the wind from off the receptacle, which has borne, first the flowers, and then the ripening seeds.

by spreading out close to the surface of the ground, they prevent any other flowers from growing near at hand. The rootstock, too, sends up several strong branches, and spreads widely, so that where a single plant has once become established, in a few years a large area may be covered with daisies. To the naturalist this is an agreeable habit, for it results in a carpet of daisies over quite a large area; but to the gardener, when once daisies have established themselves in his lawn, it makes the plant merely a rather worse weed than would otherwise be the case.

Dandelion's Irresistible Fascination

THE daisy has been quoted as an example of a flower whose colour is of little use in attracting insects, but the same cannot be said of the dandelion, another member of the same group, and one that must be as well-known as the daisy itself. The dandelion's brilliant yellow blooms are extremely attractive to insects, as anyone who cares to examine one during the heat of a summer day can find out for himself. During even a few minutes' watch, a large number of different species of insects of all types and sizes may be seen to visit it in search of nectar, and, indeed, the number of species whose names appear on the dandelion's visiting list is just about a hundred. This compares most favourably with such flowers as the sweet violet, which can be fertilized by only one or two species at any time. It is on account of the competition of such rivals as the dandelion that the violet must resort to the other means of propagation described in page 130.

Anyone who examines the dandelion will at once be struck by the difference between its flower and that of the daisy. The florets are all of one type, namely, ray florets, and are all a great deal larger than those of the daisy. Apart from this, the flowers themselves differ from those of the daisy in that they are complete, bearing both anthers and stigmas, whereas the ray florets of the daisy are devoid of anthers. There is a larger and more open involucre of bracts below the inflorescence in the dandelion, and at night and after the florets have withered the bracts close in to protect the inner parts. In the actual floret the calyx is present only as a few hairs on top of the ovary, but when the floret has withered and the seed within the ovary is ripening, these hairs grow to form the soft, silky *pappus*. The pappus opens like a tiny parachute when the seeds are ripe, and is borne away on the slightest breeze, carrying the seed on the end of a long stalk. If a seed be examined under a lens, it will be seen to bear sharp points and barbs, features which enable it to stick into the moss or among the grasses wherever it lands. Anyone who has blown away the down from the dandelion "clocks" has, probably all unwittingly, thus assisted still further in the distribution of the plant.

The Compositae are in many parts of the world the most successful of all the orders of plants in the competition for existence, and this is in large measure due to the presence of methods of distribution such as this. The down of thistles, for instance, may be borne many miles on even a slight breeze, and nearly every member of the order has some similar means of travel when it comes to seedtime.

H. Bastin

TINY PARACHUTE

This photograph of a single dandelion fruit (enlarged about 5 times) shows the little barbs at the top of the seed which enable it to stick and cling wherever it may happen to fall.

Radical leaves are also a feature of the dandelion; they are long, and deeply cut into lobes whose ends point backwards, so that each leaf is like a many-barbed spear. The stems, which are round and hollow, exude a white juice. The order Compositae is divided into several groups, according to the type of the florets, and the dandelion is typical of that known as the *Liguliflorae* (Lat. *ligula*, little tongue). The presence of white juice is a feature of all the members of this group, which are, however, best recognized by their ray florets and the complete absence of tube or disk florets.

The dandelion derives its name from the French *dent-de-lion*, meaning "lion's tooth," apparently from the shape of the leaves. It is interesting that the scientific name was formerly *Leontodon*, a word from the Greek having the same meaning, but this apt title has been removed by botanists and given to the members of another genus, while the dandelion is known now as *Taraxacum*, from the Greek words *taraxis*, disorder, and *akos*, remedy; this refers to the medicinal uses to which the plant was put in former times.

HORNBEAMS OF FOREST AND HEDGEROW

SOME people would be surprised to hear the hornbeam classed as a forest tree; others, on the contrary, would find the shrubby specimens of certain districts quite different from what their local experience has taught them to expect a hornbeam to look like. Varying so greatly in size, and resembling as it does in some respects the beech, it is small wonder that the hornbeam frequently goes unrecognized. Yet, as will be learnt from what follows, its characteristic features are easily appreciated

AMONG the larger trees of the British Isles, the hornbeam stands as something of an unknown quantity, for few people know it by sight, and by the many others to whom it is known by reputation as an admirable hedge plant, it is often mistaken for the beech, or classed wrongly with such shrubs as the privet or small trees like the hawthorn. Yet, given suitable soil, the hornbeam will grow to as fine stature as any of our forest trees, and will equal the beech, with which it is so frequently confused. This confusion is really indefensible, for the hornbeam is as distinct in appearance and character as any of our trees. The chief similarity between this tree and the beech lies in the sites where they occur, and where the one is met the other may reasonably be expected to be not far away. Yet even this statement has to be qualified, for the hornbeam is hardly ever found in such large quantities as the beech, and is confined, in a wild state at least, to the southern half of England and to Wales.

A. W. Dennis

DROOPING LOVELINESS

The catkins of the hornbeam, both male and female, are perhaps the loveliest borne by any of our trees. The scales that bear the tiny flowers are larger than usual, and both male and female catkins are pendent—the latter only after they are fertilized.

In shape the beech and the hornbeam are certainly rather similar; the same square outline is seen in each case, and the long branches that droop downwards almost to touch the ground are characteristic of both trees. The leaves of the hornbeam, too, are superficially like those of the beech, so that when we see the tree fully dressed in summer, the similarity is increased. If we examine the leaves closely, however, we find that they are really very different. The hornbeam's are very finely serrated along the edges, are not symmetrical, and are rougher and more hairy than those of the beech, and when young they are without the fringe of silky hairs. They often have that pointed tip which is characteristic of the cherry and the elms, and in page 145, where the leaf of the hornbeam is shown compared with those of the two elms, the close resemblance can be seen.

The flowers of the hornbeam, though also very different from those of the beech, betray its near relationship, and it is, in fact, a member of the same group as the birch,

HORNBEAM FRUIT

Many people would mistake the fruits of the hornbeam for leafy outgrowths, for the bracts of the female flowers enlarge enormously into curious three-lobed wings, at the base of which are borne the seeds—little, hard, and nut-like bodies. These masses of fruits hang down on short stems.

H. Bastin

the beech and the oak. We therefore rightly expect to find the feature, already noted in respect of those trees, of male and female catkins, the former being pendulous, the latter erect. The male catkins of the hornbeam, which are two or three inches in length, bear a large number of flowers, each measuring an eighth of an inch in diameter and consisting of a small bract which shields a number of stamens varying from three to twelve. The female flowers consist of two styles, which surmount a two-celled ovary; they are shielded by bracts, which soon disappear, to be superseded by three-lobed bracteoles, or "little bracts," which enlarge greatly.

Unique Fruits of the Hornbeam

After they have ripened the female catkins elongate and hang downwards, persisting into late autumn. The great bunches of their leafy bracteoles are striking features, for they are quite unlike anything that the rambler is likely to find on any other tree; they make the hornbeam completely unmistakable when it is in fruit, although they are slightly reminiscent, in the way in which they hang, of the "keys" of the ash and the bracts of the lime. The fruits which are borne with these bracteoles are hard and green, only one cell of the ovary normally developing and ripening.

It is to the fruits that one of the many derivations of the name hornbeam has been ascribed; they are said to resemble, though but faintly, the fruits of the manna ash, a tree that is occasionally to be found growing in parks and gardens in the British Isles; the specific name of the manna ash is *ornus*, and the confusion between the two trees is said to have led to the name hornbeam. A less far-fetched and simpler derivation is more probably the correct one; the wood of this tree is the toughest and hardest found in any of our native trees, and, to quote the words of John Gerard, in his "Herbal," 1633: "In time it waxeth so hard that the toughnesse and hardnesse of it may rather be compared to horn than unto wood, and therefore it was called hornbeam or hard-beam." A further suggestion that has been put forward to explain the name is based on the fact that the chief use for the wood was in the manufacture of the yokes that were attached to the horns of draught oxen; hence the word hornbeam. Whatever the derivation of the name, there can be no doubt of its aptness, as any carpenter can tell who has had the misfortune to come across a piece of hornbeam unawares. Its stubbornness soon takes the edge off the sharpest chisel, and it is the least welcome of all woods to one who values his tools.

H. Bastin

OFTEN MISNAMED

The leaves of the hornbeam reassure or perplex those who examine them, according as to whether the observer really knows the tree or not. To some, they will prove that it is not a beech; to others they may seem to be those of a curious elm. By comparison with the pictures in pages 53 and 145, we may see in what the differences consist.

FAN-LIKE SPREAD

In the case of the hornbeam the size of the tree should be judged by its spread rather than by its height. In this photograph of a very fine example, we see the way in which the short, very thick trunk gives rise to a large number of long, thin branches, radiating like the sprays of a fountain, or an open fan.

E. J. Hosking

E. J. Hosking

SUMMER EXPANSIVENESS

When in its full summer leaf the hornbeam may bear comparison with any of our finest forest trees. Allied to the wonderful spread of branches is the quality of considerable beauty of leaf, while the tree's curious, squared outline is characteristic of its growth when occupying a free and open site.

In former times, the wood was put to a number of uses, chiefly as the substance from which mill-wheel cogs and cattle yokes were made. But the cabinet-maker has never had any use for hornbeam, since it will not polish, is extremely heavy, and is apt to shrink during seasoning. In colour it is white, and the grain is very close, indicating the slow growth of the tree. As fuel, however, this wood has a great reputation; it makes wonderful charcoal, and, according to Evelyn, burns " like a candle." But in times when coal and electricity have ousted wood for purposes of heating, even this property is valueless, and it would seem that the chances that the hornbeam will ever become a popular tree are exceedingly remote.

But the hornbeam has one great property, already touched on, for which it is almost unrivalled: it makes superb hedges. This may seem strange in a tree that can take its place among the stateliest and grandest in the land, but it is true, none the less. The hornbeam hedge is slow-growing, straight, tough and very strong. The branches and twigs of the young trees interlace in a

remarkable way, forming almost a wall rather than a hedge. They have the additional advantage that they do not lose their leaves in the winter, so that as a wind-shield the hedge is doubly useful. In autumn, the leaves die off, turning first yellow, then gold, then a rusty copper colour, but they remain until they are thrust off by the sprouting buds of the following spring. This is true only of hedge-hornbeams, and on fully-grown trees the leaves usually fall in the normal manner. The buds provide us with a means of telling the twigs of the hornbeam from those of the beech, for they are shorter and fatter, and are more closely pressed to the sides of the twigs.

Features of the Hornbeam Trunk

THE bole of this tree is thick and strong, but there is often no main trunk. Some ten or more feet above the ground it divides to form a number of long branches, more numerous and thinner than those of the beech, and these branches grow upwards and outwards in all directions. The bark of the bole is greyish, and is split longitudinally, the pattern consisting of larger lens-shaped areas than are to be found in most trees whose boles are of similar design. One curious feature about the trunk is that it is seldom symmetrical. When cut down, the bole will be found to be decidedly oblong, being flattened on two sides.

British Museum (Natural History)

PATTERNED BOLE

Of our trees one might well say that "by their boles ye shall know them," and above the testimony of the hornbeam bole is in evidence. Erect and thick, with grey bark marked with lighter flakes and darker fissures, it is as unmistakable as are the boles of such trees as the oak and the pine.

M. H. Crawford

POLLARDED BY RIGHT

These pollarded hornbeams in Epping Forest remind us of the days, not so very far distant, when the right of "top-lopping," as it was called, the hornbeams and other of the smaller trees of the forest for winter fuel was one of the most cherished privileges of the commoners

In dimensions, though not in the same class as the elm or the pines, the hornbeam can compare very favourably with most of our forest trees. Its size depends, of course, on the soil in which it is growing, and on the treatment which it has received as a young tree, but, given good, rich loam or clay and safety in youth from the damage wrought by villagers in search of firewood, it should reach a height of seventy feet, with a girth, measured several feet above the ground, of ten feet.

Pollarding in the "Good Old Days"

IN former times hornbeams were much pollarded, and those in Epping Forest, a district which might well be termed the headquarters of the tree—at any rate, near London—have especially suffered from this practice. It is not entirely a disadvantage, however, for the custom of "top-lopping," as it was called, for winter fuel was, from the days of Elizabeth, and no doubt earlier, one of the most highly valued rights possessed by the commoners over the woodland. When the Forest finally became public property, the commoners were compensated for any loss in the way of fuel which they might suffer through being no longer permitted to feed their fires with hornbeam lops.

OUTSTANDING EXAMPLES OF BRITAIN'S MULTITUDINOUS MOTHS

The twenty-nine moths pictured above, in their actual colouring and almost life-size, are typical of the more than two thousand found in the British Isles
1 Dark crimson underwing. 2 Goat. 3 Garden tiger. 4 Drinker. 5 Death's head hawk. 6 Kentish glory. 7 Scarlet tiger. 8 Clouded buff. 9 Green silver lines. 10 Broad-bordered yellow underwing. 11 Eyed hawk. 12 Five spot burnet. 13 Clifden nonpareil. 14 Six spot burnet. 15 Privet hawk. 16 Treble bar. 17 Leopard. 18 Lappet. 19 Puss. 20 Argent and sable. 21 Magpie. 22 Lime hawk. 23 Brimstone. 24 Beautiful golden Y. 25 Elephant hawk. 26 Large emerald. 27 Oak eggar. 28 Cream spot tiger. 29 Red underwing.

To face page 435

BURNETS AND OTHER DIURNAL MOTHS

MOST moths are creatures of the dusk and night-time, but some there are—notably the burnets, the silver Y, the Mother Shipton and the burnet companion—which are usually seen pursuing their way from flower to flower in the hours of daylight. All are treated of in the chapter below, and the six-spot and five-spot burnets are pictured, in their actual colouring and approximately life-size, in the colour plate facing this page

AMONG the most characteristic insects of the chalk downs are a number of small moths whose wing-span is about an inch and a quarter and whose general colour is green with red spots. These are the burnet moths, of which there are three common species that are widely distributed, and several scarce species, and all are fond of situations where there is plenty of sun and long grass. They are easily recognizable by their curious whirring flight; as they buzz to and fro among the flowers and grasses of their favourite haunts they look more like large bees or flying beetles than moths. The commonest is the six-spot burnet, a description of which will suffice for all of them, for the differences are slight but quite easily noticed when one is acquainted with all three species.

B. Hanley

SIX-SPOTTED GOURMET

The six-spot burnet moth is one of the commonest day-flying moths, and may also often be seen at rest, feasting (as in the photograph above) off some such flower as the knapweed. Very handsome is it, with its deep blue-green wings spotted with scarlet. (Slightly enlarged.)

The fore-wings are green, and have six brilliant red spots arranged in pairs. As to these spots, they may all coalesce into a single large red patch; the lower spot of the outer pair may be absent; any of the pairs may join to form patches; and the red colour may be replaced by pink, orange, or, very rarely, pale yellow. The hind wings are of the same crimson as the spots, but with a green border, and the body, which is rather stout, is greenish-black or very deep blue-black. A special feature common to all these moths is that the antennae are more like those of the typical butterfly.

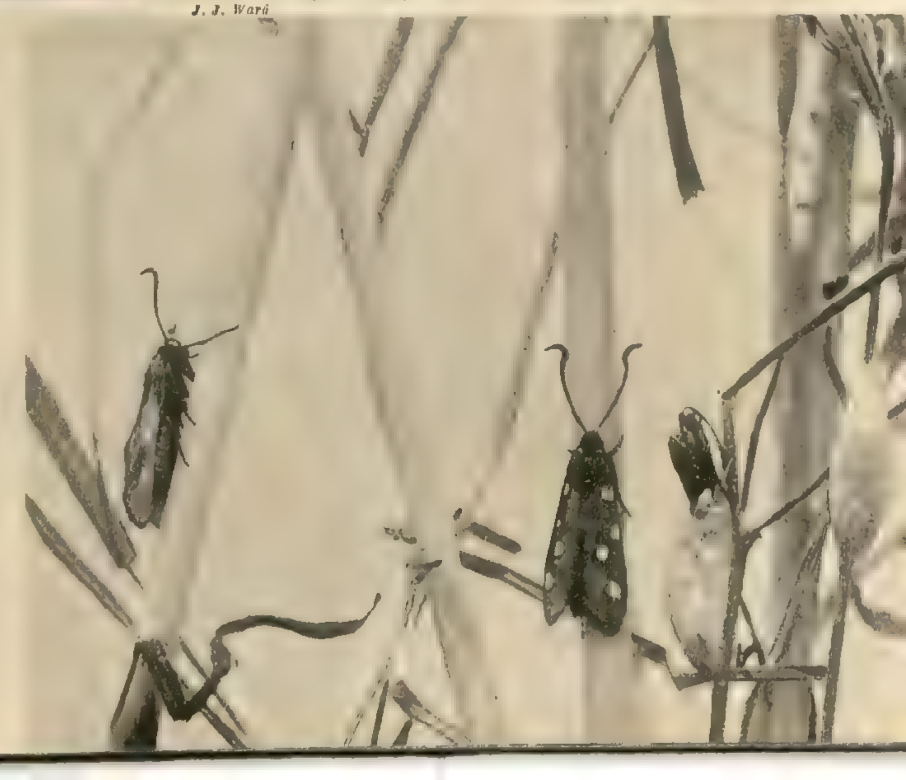
Another common burnet moth is the five-spot burnet, in which the two outermost spots are replaced by a single spot. The insect is in all other respects similar to the six-spot, except that the green border round the hind wings is considerably broader than in that species. Here, again, we find a large number of varieties, covering the same range as that described above; there is also a very rare variety in which a sixth spot is present, so that the insect bears a still greater superficial resemblance to the former species. In some cases, in fact, it is found that only a detailed examination of the insect's internal anatomy will suffice to show which it is.

The narrow-bordered five-spot burnet is also very common, and its range extends farther north than that of the last species. There is no doubt that to the beginner the two will appear almost identical. Actually the narrow-bordered five-spot has rather longer fore-wings, and more pointed hind wings, while the green border, as the

BURNETS AT REST

Below we see illustrated the two final stages in the life of the five-spot burnet. On the left is an adult that has just emerged from the pupa; next to it is another adult, whose pupa projects from the cocoon on a neighbouring stem. The spindle-shaped object attached to the grass-stem on the right is a cocoon whose occupant is as yet unhatched. (Slightly enlarged.)

J. J. Ward



SPOTTED PROGRESS

This fine moth sequence from a large collection shows the extent of the variation found in the five-spot burnet. From the typical form in the left-hand column we see (reading down each column) that the spots coalesce more and more until they are all joined into one irregularly shaped patch of colour. (Natural size.)

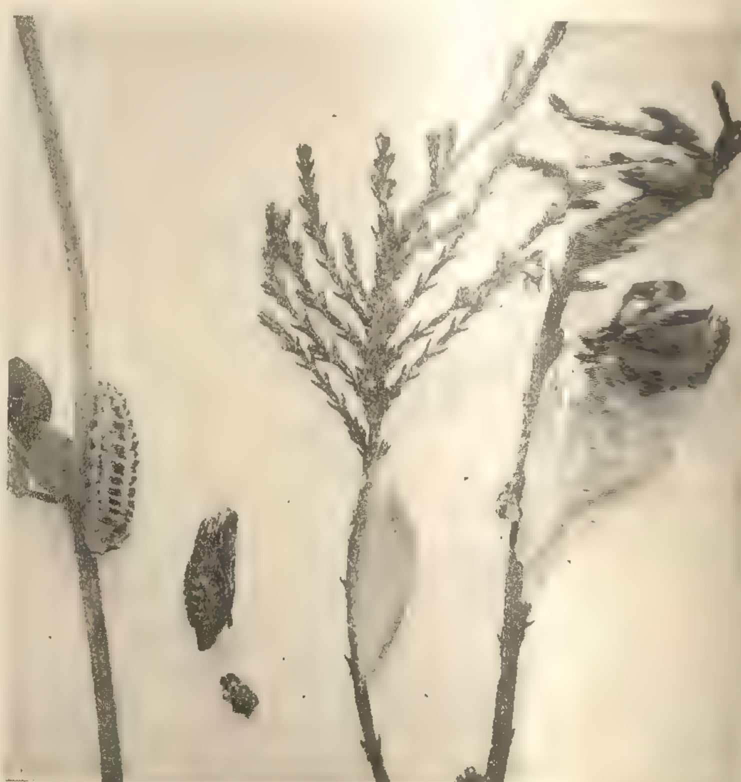
name implies, is often narrower. The general colour of the wings is frequently bluer than that of the five-spot. Varieties such as those mentioned above are, however, very much less frequent in this species, although they do occur over the same range of form and colour of the spots.

Other species of burnet moth include the New Forest burnet, a small, five-spotted species with rounder wings that are almost transparent; it is confined to the New Forest, in Hampshire, and is by no means common even in that locality. Then there is the transparent burnet, which is found in certain places in Ireland, Scotland and Wales. This species has the spots run together as if they had been put on carelessly with wet paint; the wings are transparent with a very faint greenish tinge. Two other species are found very occasionally in parts of Scotland, but they need not concern any but the specialist or very expert entomologist.

Caterpillars and Pupae of the Burnets

In the larval and pupal stages all the burnets are very similar in appearance and habits, and a simple description of these stages in the six-spot burnet will suffice for all of them. The caterpillars are short and fat, with small heads, and are covered with a large number of hairs. The general colour ranges from yellowish to bluish green, and there are a number of black spots on each segment, those low down on the sides being of horseshoe shape. Burnets feed chiefly on plants of the pea family. When the caterpillar is fully grown it climbs up some tall, thin, stiff stem, and there weaves a curious, spindle-shaped cocoon, in which it turns into a pupa. These cocoons are common objects of the chalk downs and other districts where the burnets are found, and many ramblers must have wondered what they are. Often in the summer when the burnets are hatching out, they may be seen actually emerging, or hanging limply on the grass stems while they wait for their wings to dry. The burnets tend to be restricted in their occurrence to those places where their food plants grow, but in such localities they are often found in very large numbers. A curious fact about them is that it seems possible for all the three common species to interbreed, so that, according to some authorities, they have not as yet evolved into true species.

Most of our moths do not fly in the daytime, unless they are suddenly disturbed from their resting places, but there are several notable exceptions to this rule. The burnet moths, described above, are all diurnal, and invite attention by their laborious flight. A moth which is also usually seen in the day, but which has very different powers of flight, is the silver Y, one of our commonest moths. This is an insect which every rambler must have seen at one time or another, for it gets up suddenly from the herbage at our feet, flies very rapidly for a few yards, and then settles again, only to be disturbed when



A. E. Tonge

FIVE-SPOT HISTORY

On the left of this photograph we see the larval and next it the pupal stages of the five-spot burnet. The pupa is contained in a cocoon (centre), from which it half wriggles (right) prior to the emergence of the adult. In this photograph the objects are shown very slightly enlarged.

we are once more almost on top of it. While it is in flight there is very little opportunity of observing its appearance or coloration, but if we are able to approach it without disturbing it, we can appreciate its beauty.

The feature from which the moth gets its name is a Y-shaped marking, whitish or almost golden in colour, in the middle of the fore-wings. The ground colour of the fore-wings ranges from greyish to very deep purplish brown, with markings of a similar colour. The edge of the fore-wings is slightly scalloped, and there is a light thread-like line of colour from the upper and inner end of the Y to the rear margin of the fore-wings. Near the base of the Y there is often a reddish patch of colour. The hind wings are greyish-brown on the outer areas, shading rather suddenly to a dirty whitish inside; this scheme of coloration is common to many of our English moths, especially those of the great family *Noctuidae*, some of whose members are described in another chapter.

Drawn to Death by the Lamp

The silver Y is the moth most usually attracted into our houses by light, and when we are sitting with open windows in the warm summer evenings there may be as many as a dozen of them flying wildly round the lamp. Only too often some of the hapless insects singe their wings and fall, with a last pathetic flutter, to the floor at our feet. If we see a specimen of this moth that has only recently emerged from the pupa, we shall notice along the back of the thorax and abdomen a wonderful crest of tufts, but after the moth has spent a day or so fluttering among the grasses and leaves out of doors this is almost all rubbed off.

An obvious reason for the commonness and wide distribution of the silver Y is the fact that the caterpillar—which ranges through all shades of green—will eat almost anything in the way of low-growing herbage; it is often to be found eating flowers in the garden. The moth is a representative of a largish group which includes some of our loveliest insects. The burnished brass is one in which the fore-wings are of a brilliant golden colour, crossed by a brown band, which, however, is often broken into two spots. Another species which is a not very distant relative is the herald. This strikingly beautiful insect is quite unmistakable. The fore-wings, which are curiously indented along their outer edges, are of a pale purplish or greyish brown, which appears to be powdered with a brilliant scarlet. This latter colour runs in a flame-like patch from the body outwards to the middle of the wings, which are there crossed by a double line of white. The hind wings are of a uniform yellow-brown colour.

A. E. Tonge

MOST COMMON MOTH

The silver Y, or gamma moth—both names refer to the marking on the fore-wings—is perhaps our commonest moth. These pictures (top, × 1½; others, life-size) show it with the wings spread wide (top), seen from above (centre), and in profile (bottom).

The crested appearance of the body, noted under the silver Y, is exaggerated here, and the crests are of the same scarlet colour as suffuses the wings. The body is broad and square. This moth spends the winter in hibernation, and it is often found in barns and outhouses and similar dark places during the period of hibernation.

Two other diurnal moths related to the silver Y are the Mother Shipton and the burnet companion. The former, illustrated in this page, has brown wings with yellowish markings. The latter has warm brown fore-wings crossed by two bars of a darker colour, and there is a patch of this same dark colour near the tip of the wings. The hind wings are brown, with orange-yellow outer areas crossed by a brown line.

A. E. Tonge

'MOTHER SHIPTON' OF THE MOTHS

Mother Shipton was a famous 16th century witch, and on the fore-wings of the moth that bears her name (right, above), are yellowish markings supposed to resemble her unprepossessing profile. The larva of this moth (left) is long, thin and green, resembling the blades of grass among which it lives (left, × 1½; right, × 2 approx.).

SHARKS THAT PROWL OFF BRITAIN'S SHORES

THERE is something exotic about the shark's name—something suggestive rather of the waters of the tropics than of those that surround our homeland. Yet sharks are no strangers to our waters, as many a fisherman can vouch. Several species—fifteen, to be exact—are found in British seas, and it is consoling to know that only one of these is included in the man-eating category, and it is not seen near the coast

THE name of shark conjures up a mental picture of savage, predatory fish of bloodthirsty humour and monstrous appetite, whose presence in the seas is a ceaseless menace to Man, and most people will be surprised to learn that sharks are of quite common occurrence off the British coasts. Let this information, however, deter no one from bathing, for it is comparatively seldom that a British shark is met in inshore waters, and even then it is unlikely that it will attempt to molest a human being, for though there are fifteen different sharks found in British seas, only four of these belong to the family of true sharks, and of these four only one, the blue shark, is a man-eater.

Before embarking on a description of the various sharks it will be well to differentiate between them and the whales and porpoises, or *Cetacea* (Gr. *ketos*, sea monster), so that the two groups may not be confused. To the ordinary observer the main difference lies in the tail, for whereas the sharks, in common with all fish, have their tails in the vertical line, the tails of the cetacea are all in the horizontal line, i.e. at right angles to the dorso-ventral line. But there are several other points of difference. The sharks, of course, have gills with external opening, whereas the whales, being mammals, breathe by means of lungs, and the only additional external opening they have is the blowhole, a small opening at the top of the head through which they expel water; the sharks have a rough, scaly skin like the dog-fish, while the skin of the whales and porpoises is comparatively smooth; the sharks possess two pairs of fins, while the whales and porpoises have only one pair of paddles; the sharks usually have two or more rows of teeth, while the whale has either whalebone, or, at most, one row of teeth.

All these features, however, are external, and such as can be noted by observation alone, and these sea beasts do not always give us the opportunity of studying them long enough or minutely enough to note these differences. It is usually necessary, therefore, to mark the manner in which the animal moves through the water. If it appears to break surface with a rolling motion—the forepart appearing first, followed by the hinder part—then it is most probably one of the cetacea, for such a method of progression is typical of the whales and porpoises. If, on the other hand, no such rolling is evident, but the dorsal fin and part of the back are seen gliding through the water, the animal is a shark. Both the cetacea and the sharks will jump clean out of the water on occasions, and if they do so near at hand, when one is in a small boat, the experience will remain a vivid memory.

Britain's Only Man-eating Shark

THE four groups of sharks are the true sharks, the *Lamnidae*, the six-gilled sharks, and the spiny sharks. Of these four groups, that of the true sharks is the most important to Man, since it includes the blue shark, which is one of the predatory sharks, ready to prey on anything weaker than itself, and the tope, which is included amongst the game fish of the British seas. The blue shark is essentially a predatory fish, swimming near the surface, its body well adapted for moving swiftly through the water in pursuit of its prey. In length it may grow to 25 ft. or so, and specimens measuring about 15 ft. are caught in the nets of fishing fleets from time to time. It is coloured dark blue on the upper surface of its body, and it has large triangular teeth. It is found chiefly off the Scottish and Irish coasts.

Usually attaining a length of about 5 ft., the tope is one of our smaller sharks. It resembles the blue shark in

TIGER OF THE SEAS

The blue shark is the only man-eating shark that enters British waters. Luckily, it is not a common visitor and does not frequent shallow water, so that visitors to the seaside need have little fear of encountering it when bathing. It occurs with some regularity off the coasts of Scotland in the late summer.

W. S. Berridge

W. S. Berridge

FORMIDABLE JAWS

All sharks are armed with prodigious teeth, some of which are sharp and used for catching smaller fish, while others are blunt and adapted for crushing shellfish. These teeth are always renewed if they are lost, since they are only modified scales.

being ferocious and a greedy feeder, often taking the bait of line fishermen and snatching away their fish when hooked. For this reason the tope is the shark most often caught by sea anglers. It is viviparous, about thirty young being produced at one time. In company with many other fish that are difficult to market, the flesh of this small shark is sold as Darwen salmon.

Other True Shark Visitors

Of the true sharks which are found off our coasts the other two members are the smooth hound and the hammer-headed shark. The smooth hound somewhat resembles the tope, but is smaller, usually not exceeding 3 to 4 ft. in length. Like most of the sharks, the smooth hound is found inshore in the summer months, when the fish spawns. Like the other sharks, it is viviparous, but, unlike them, it feeds mainly on molluscs and crustacea, and for this reason its teeth are more adapted for crushing.

The hammer-headed shark is easily distinguishable from the other true sharks by the shape of its snout, which has two lateral projections that give it the peculiar appearance responsible for its name. It is a tropical species, being found only on rare occasions in British seas.

The second large group of sharks, the *Lamnidae*, includes three species, all common off our coasts: the porbeagle, the thresher and the basking shark. The porbeagle is one of the fatter sharks, being deeper in the dorso-ventral line than most of the other species, but in spite of its bulk it is an agile fish and feeds largely off smaller fish such as whiting and mackerel, and it will not hesitate to take fish already hooked. Although viviparous, the porbeagle is not nearly as prolific as the tope, producing on an average only three or four young at a time. This shark may be seen from time to time off our coasts, for it is not as uncommon as is sometimes supposed; if one should observe a large fish, about 10 ft. in length, leaping from the water it is most probably one of these sharks.

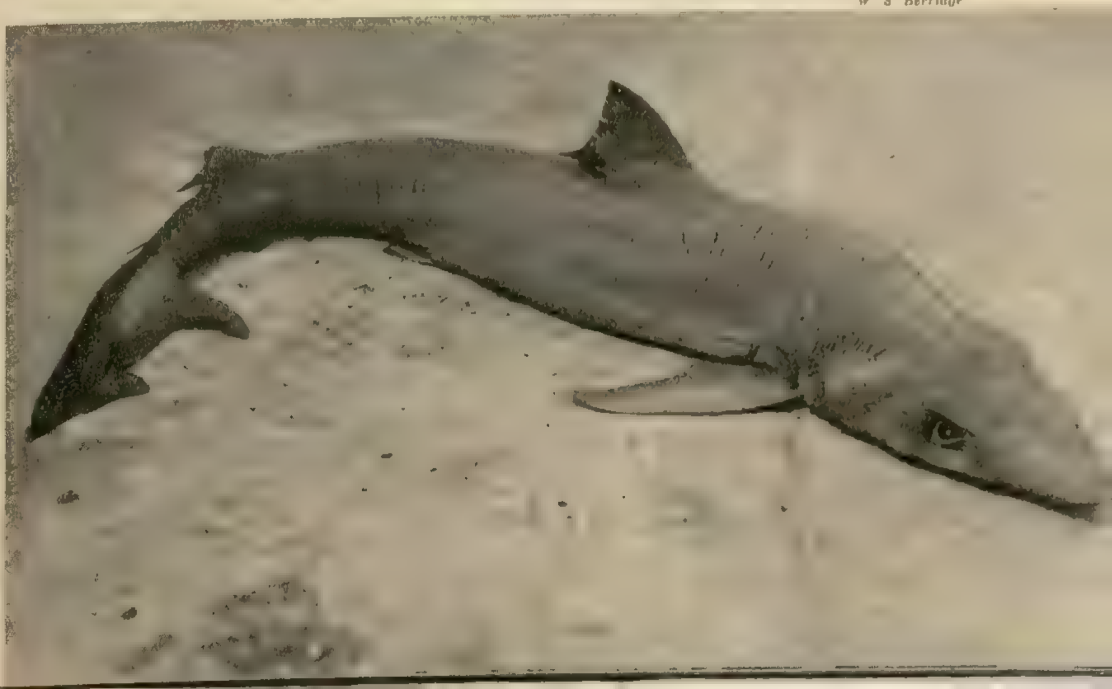
The second member of this group, the thresher shark, is one of the most interesting of fish, for it has a long tail with the upper caudal fin modified so that it projects in a long, whip-like ribbon, with which it lashes the water. The tail measures about half the total length of the fish itself, which averages about 15 ft., and it is stated that it is used for the purpose of rounding up fish, much as a rancher wields a whip for rounding up cattle. This assumption is borne out by the fact that the thresher is caught in the nets of trawlers that are fishing for mackerel and herring.

Largest of all the British sharks is the third of the *Lamnidae*, the basking shark, specimens of over 30 ft. in length having been recorded. It might be supposed that the larger the shark the fiercer it is, but, like many large animals, the basking shark seems to have a placid and even sluggish disposition, quite different from some of the smaller, more voracious sharks. It is peculiar in that it

FREQUENTLY CAUGHT

The tope is one of our commoner British sharks, and of recent years has earned the reputation of a game fish. It measures on an average between four and six feet and weighs between 20 and 50 pounds. It is a bottom-feeding shark and is often caught accidentally by fishermen angling for other fish of similar habit

W. S. Berridge



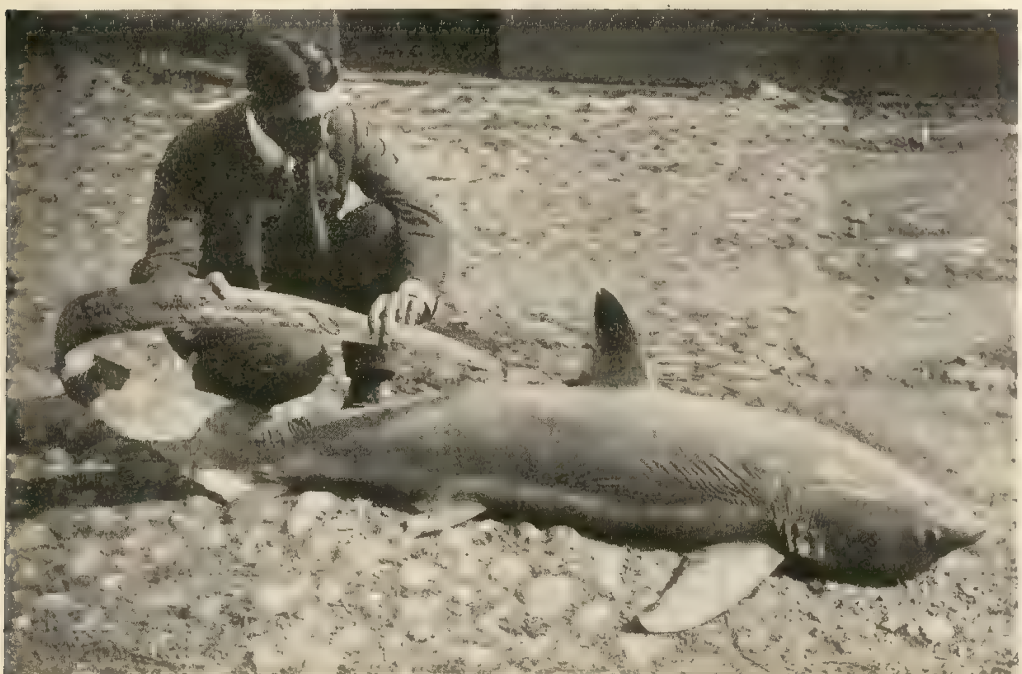
lives on small organisms floating in the sea, as is the habit of the whales, and for this purpose it has developed gill-rakers, which serve as a sifting organ, to separate the food supply from the water. The basking shark lives in the North Atlantic and is recorded on the west and north coasts of our islands each year. It is a harmless, non-predatory species, and causes trouble only when it crosses the path of small boats, since it frequently cruises on the surface or only a few feet below.

STRANDED PORBEAGLE

The porbeagle is another common shark, and, like the tope, sometimes provides sport for the big-game angler. It is a medium-sized shark, measuring seven to ten feet in length and weighing 350 pounds or more. It is not a dangerous species.

The remaining sharks are of rarer occurrence and less importance. The six-gilled shark is an infrequent visitor, named from the fact that it has six gill-slits instead of the usual five. Then there are the spiny sharks, of which the spiny dogfish, the spinous shark and the Greenland shark are the commonest in our seas. The spiny dogfish is, as stated in page 385, not a dogfish, although it somewhat resembles the greater spotted dogfish. The spinous shark, unlike the spiny dogfish, has no spines on its dorsal fins; instead, it possesses spiny tubercles over the surface of its body. It is a medium-sized shark, measuring 8-9 ft. when full-grown, and leads a predatory life. It has been frequently caught in British seas. The Greenland shark, a northern species measuring 15-20 ft., is of sluggish habit, unlike the agile predatory shark, and consequently is of larger girth. It has been reported as feeding off the carcasses of dead whales, and so it would seem that it acts as a scavenger of the seas. It occurs most commonly off the northern coast of Scotland. The remaining sharks of this group, such as the humantin and Darkie Charlie, are caught by British fishermen, but most usually outside the limit of British waters.

It is from fishermen's hauls that most of the captured sharks come, especially frequent in this respect being the tope and the thresher shark, which are caught when pursuing shoals of herring and mackerel. The capture of sharks in this way is more of a loss than a gain for the fishermen, for in its struggles to free itself the great fish lashes about with its tail, doing great havoc to the nets. In addition, there is always the risk of a broken limb for one of the crew, until a skilful blow on the snout dispatches the beast. Some sharks may provide sport for the big game angler, but they are all a pest and a nuisance to the professional fisherfolk.



W. S. Berridge

LONG-TAILED THRESHER

The thresher or fox shark is remarkable on account of the great extent of its tail, which accounts for about half the total length of the fish. This fish is rarely caught on rod and line, so that records of its appearances are incomplete. It grows to an average length of fifteen feet.

A FURTHER STUDY OF CLOUD FORMS

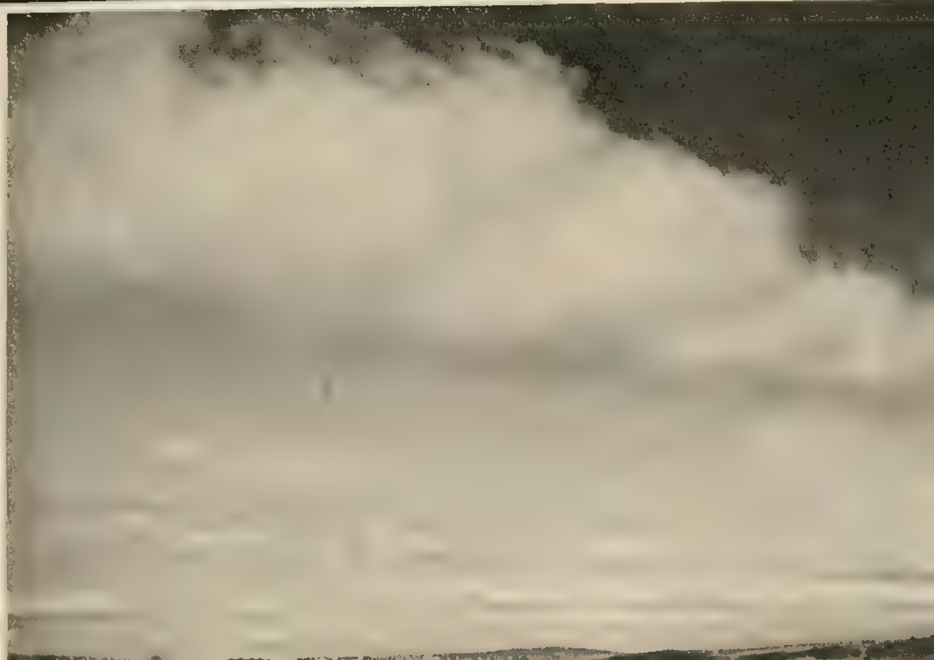
In the previous chapter in this series (see page 335) the internationally adopted classification of the clouds is quoted and explained, and the principal cloud-forms are illustrated by photographs of actual examples. In the chapter that follows the study is continued, and, in particular, several less important but nevertheless frequently observed forms are described and pictured

At the end of Chapter 4 in this series (page 335) a list is given of the ten varieties of clouds as laid down in the International Cloud Atlas. These ten main types, which are to be found in all three layers at different altitudes, also fall into a further system of division, which classifies them solely according to their shape. In the Cloud Atlas mention is made of most of the possible shapes which may be assumed by any of the ten types of clouds. The number is large, of course, and, as is the case with all systems of cloud classification, numerous subdivisions occur; but these are not of sufficient importance to warrant mention here, and all the shapes can be included under three main headings.

The first of the cloud-shapes is known as *lenticularis*, which in abbreviation is always written *Lent.* A lenticularis cloud has a lens-like appearance; the shape is not very common in this country, being associated mostly with Mediterranean climes where specialized winds like the föhn, the sirocco and the mistral blow at certain times of the year. Lenticularis clouds seem to appear at all levels from cirro-stratus to stratus, and clouds with a lenticular formation are classified as "cumulus lenticularis" (Cu.-lent.), "alto-cumulus lenticularis" (A.-Cu.-lent.), and so on.

Some clouds whose under-surfaces belong to quite a different form may branch out on top so that their upper parts have a cumulus-like appearance, and they are then known as *cumuliformis* (*Cuf.*). These clouds may occur at all levels from cirrus to stratus, but are most common in the intermediate layers. A very important member of this particular group is called *alto-cumulus castellatus* (*A.-Cu.-cast.*). This is a layer of alto-cumulus clouds in which some of the separate masses of vapour have developed cumuliform heads and turrets (*castellatus* is Low Latin for "turreted"). These clouds often occur a little while before the arrival of a thunderstorm, and are a

G. A. Clarke



'LENT.' AND 'CUF.'

Two of the less frequently observed cloud-forms are illustrated in these photographs: above, lenticularis (Lent.), being, as the name suggests, lens-shaped; right, cumuliformis (Cuf.), parts of which have assumed a cumulus-like appearance.

great help in the forecasting of any type of electrical atmospheric disturbance.

The third and last of the cloud-shapes which deserve special attention is the *mammatus* (*Mam.*), a name that is applied to all clouds showing rounded projections or udder-like protuberances in their under surfaces. Clouds of this kind are classified as alto-stratus mammatus (A.-St.-mam.), etc.

Apart from their types of formation and the layers in which they occur, clouds may be separated into two further subdivisions: (a) cloud sheets; (b) heap clouds. Cumulus and cumulo-nimbus are the only heap clouds, and the classification is thus rather one-sided, the other eight types coming under the heading of cloud sheets.

G. A. Clarke

THUNDER PORTENTS

Alto-cumulus castellatus, seen above, is a subdivision of the cumuliformis group and may be defined as a layer of alto-cumulus on which some of the clouds have developed as turrets—hence the name. Usually A. Cu.-cast. is a precursor of thunder.

Heap clouds may be recognized by their great depth; they never form horizontal layers. They are caused by the vertical ascension of moisture-bearing air which has been warmed when lying near the earth's surface. As is pointed out in the chapter dealing with rain (p. 247), whenever air is heated, owing to its expansion it will rise into the regions of diminishing pressure which exist at higher altitudes. As it rises it cools both through the operation of "dynamical cooling" and the increase in the distance from the earth's surface from which are reflected the warming rays of the sun. This cooling of the moisture-laden air causes the moisture to condense as drops of water about the nuclei formed by the impurities of the atmosphere. If the weight of these drops becomes sufficient, they begin to fall, and the cloud deposits rain, being then said to be "nimbus." Heap clouds may thus often be an indication of wet weather, although, as they occur at both ends of a cyclone, they may sometimes be nothing more than the remains of yesterday's storm. The heights at which heaped clouds appear are very variable, but it has been estimated that the average distance of the base from the ground is about 4,500 ft., though they are sometimes found considerably lower than this. The heights of their summits vary between 6,000 and 25,000 ft., so that a single cloud may often pass through all three layers.

MAMMATUS FORMATION

When the lower surface of a cloud sheet has a number of udder-like projections hanging from it, the cloud structure is described as being "mammatus." This picture shows a mammatus structure in a cloud sheet occurring in the intermediate layer.

G. A. Clarke

Cloud sheets extend more in a horizontal direction than vertically, but they are difficult to recognize, for they often have breaks in them which confuse those unused to the identification of cloud masses. The sheets frequently vary so much in thickness and are so broken that only very skilled observers are able to realize that the formation is one which, if not actually sheet-like, is at least distinct from "heaped clouds." Often the sky will show several cloud sheets, or layers of cloud, appearing at different levels all at the same time. From these facts it will be clear that the height of a cloud sheet may vary within very wide limits, for cirrus, cirro-stratus and cirro-cumulus occur generally at above 25,000 ft., alto-stratus and alto-cumulus between 10,000 and 25,000 ft., and the strato-cumulus and the nimbo-stratus, which may also be cloud sheets, are often observed below 7,000 ft.

By Pond and Stream. 3

BRITAIN'S COMPLEMENT OF TOADS

TOADS and frogs are so much alike—at least, to the eye of the casual observer—that they are frequently mistaken for each other. From what is said on the subject below, however, it will be realized that the two animals may be readily distinguished. The principal distinctive features are clearly set forth, together with much information concerning the everyday habits of the toad on land and in water. Frogs are dealt with in pages 133-136

TOADS can be easily distinguished from frogs by their outward characteristics. They are dry and look as if they are covered with warts, while frogs have damp, slimy skins. The hind legs of the frog, being adapted for swimming, are very long in proportion to its body, while the toad, which spends most of its time on dry land, has comparatively short hind legs. If the mouth of a toad is opened and the little finger inserted into it, the "gums" will be found to be quite smooth and devoid of teeth, but if the same experiment be carried out with a frog the microscopic teeth fringing the upper jaw and on the roof of the mouth will be felt. The tongue of the frog is notched, while the toad's is rounded. The toad, too, has a much flatter back than the frog, while the pelvic bones (those on to which the legs join) are not produced at such a sharp angle, thus still further decreasing the length of the legs. The toad is, in fact, far more solidly built than the frog, and the broad head and short limbs make it look much more portly. The texture of the skin is so rough as to give it an almost leather-like appearance, which is by no means so pleasing to the eye as the bright, shining coat of the frog.

Is It a Frog or a Toad?

IN temperament the toad is much more phlegmatic; it has patience enough to sit for hours hidden under a stone or in a hole in the ground while an enemy circles round in search of it. The frog, on the other hand, will almost immediately come out into the light of day and make for the nearest pool, where it will find itself more at home among the water-weeds. If the rambler by pond and stream happens to come across a batrachian and cannot decide whether it is a frog or a toad he should touch it on the head and watch its reactions. A frog will almost certainly rise on all four legs, and after one look hop away, while a toad will immediately crouch down to the ground and endeavour to make itself as inconspicuous as possible. The toad is far too heavily built to try to leap at all, so, instead, it is forced to progress by very short jumps with all four feet at once, which give the impression that a great effort is made every time it moves. There is, perhaps, only one time when the toad looks really alert, and that is when it is considering the best way to attack some form of prey. It will then sit back on its hind legs almost like the frog, and, cocking its head first on one side and then on the other, advance slowly with a crawling motion towards its victim. There is no sudden spring or any other agile movement; the whole process is one of slow and persistent stalking. The resemblances, then, of toads and frogs are not so great as may at first appear.

There are two species of toads in Britain—the common toad (*Bufo vulgaris*) and the natterjack (*Bufo calamita*). A third, the midwife toad (*Alytes obstetricans*), is an importation from the Continent and is of very local distribution. With regard to size, the common toad averages in length about 2½ ins. for the males, while the females are sometimes as much as 1½ ins. longer. Cases have been recorded of females 6 ins. in length excluding the legs, but these are very rare, and such specimens are always very old and have probably been able to find for themselves particularly good feeding ground. The natterjack and the midwife toad rarely exceed 2 ins. in length, the former being much lighter in colour, and having a distinctive narrow, yellow line which runs along the centre of the head and back. The legs of the natterjack are far shorter than those of the common species, and instead of crawling it runs for a short distance, stops and then runs on again.

The coloration of the toad's skin depends on the species and the locality in which the animal lives. In a sandy region the common toad may have a reddish hue, varied with spots of a rich or dirty brown. Generally speaking, toads are brown, and spotted with black, but in areas where clear chalk streams flow through the countryside the colour at the bottom of the stream seems to affect the skin of the young toad and make it considerably lighter, though how this is accomplished it is difficult to say. Some naturalists suggest that the pigmentation of the skin is dependent on the light to which the young toad is subjected, and that if it is bred in a chalk stream where the bottom reflects much of the light from the sky, the skin of the toad tends to grow lighter—unlike the skin of Man, which goes brown with

NOT QUITE AT HOME

The toad is by no means so much at home in the water as the frog, and looks singularly out of place when seen floating at the surface as in the picture below. The nostrils are held just out of the water, with the mouth beneath the surface, and the hands are spread out so as to give more stability.

Berridge; Crawford

TOAD DEVELOPMENT

The story of the metamorphosis of the toad varies very little from that of the frog, pictured in pages 134-5. The chains of jelly containing the eggs develop into tiny black tadpoles; these in turn grow legs and absorb their tails, just as do frog tadpoles, and after a few weeks the tiny toads are free to leave the waters of the pond and take to dry land.

more sunlight. It has been suggested that the light skin of a toad in a brightly lighted stream enables it to remain hidden from its enemies, while in a dark stream a dark skin would have the same effect. Toads have been found with an olive tinge, and an almost black coloration has been observed in some specimens in Somerset.

SINCE the toad rarely comes out of hiding except in the twilight the generally dark coloration of its skin tends to make it almost invisible, but this is not the only way in which it protects itself from its enemies. The numerous tiny bumps which give it such an unpleasant appearance are not there merely for camouflage, but are glands which, when the animal is disturbed, are capable of secreting an extremely offensive and unpleasant acid. Although these secretions will not inconvenience those who wish to pick up and handle toads, care must be taken to wash the hands afterwards, for if any of the secretion comes into contact with an eye, a lip, or any mucous surface, it will sting and burn unpleasantly. An excellent example of the protective value of this secretion may be had by watching a puppy or inexperienced dog attempt to hunt a toad. Something in the appearance or, more likely, the scent of the toad warns the dog at once of danger, but in spite of this it will usually attempt to bite at the toad as it sits crouching on the ground. It may even pick the toad up in its jaws, but if it does so it will quickly drop it and jump away, its mouth frothing from the effects of the irritating secretion.

As in the adder, the parotid glands situated on the side of the head behind the eyes are largely developed in the toad, and appear as two large bumps, which constitute one of the most distinctive features of the animal. These swellings are porous and the underside of them is whitish, shading to yellow or brown and sometimes even red. It is from these glands more than from any of the others situated over the surface of the body that the secretion above-mentioned may be exuded.

Croaking During the Breeding Season

THE male common toad has no vocal sacs of any kind, but is capable of making a certain amount of noise—of a croaking nature during the breeding season, and of another kind when frightened. This [illegible]king of the common toad is a subdued noise, and one [illegible]t is unlikely to be heard except by those who make [illegible]cial study of this ugly but interesting batrachian, [illegible] prepared to watch it with some patience, so that they may catch it in the act of croaking. The natterjack, [illegible] other hand, develops large, internal vocal sacs at the [illegible]ding season, which cause a great bulging of the th[illegible] By means of these sacs this toad is capable of mak[illegible]onsiderable noise, far louder even than that of the [illegible] frog.

With the coming of spring the [illegible] which are ordinarily land-living animals, find their way back to their ancestral homes in the ponds—probably [illegible] same ponds where they were hatched. The comm[illegible]ls are very particular as to their breeding grounds, [illegible]lthough on their journey towards the water in the [illegible] time they may pass numerous ponds which would [illegible]r perfectly suitable, they cannot be turned from their [illegible]h until the usual breeding ground has been reached. The natterjack, on the other hand, will breed in any suitable water. Like the frog, the male toads of all species develop at this time a swollen pad on the thumb of each hand, which enables them to clasp the female more easily. Once in the water, pairing takes place while the female is actually exuding the spawn which is fertilized by the male sperm in the water.

As soon as the breeding season is over the parents leave the water and wander about while the gradual

A. R. Thompson

COMMON TOAD

The toad has a much flatter back than the frog, and the hind legs are not so long in proportion to the length of the body. The animal has a characteristic "earthy" appearance, which is accentuated by the texture and dull colour of its skin.

development of the eggs proceeds. These are somewhat smaller than those of the frog, and are contained in strings of jelly which may be from 10 to even 15 feet in length, each string containing from 2,000 to as many as 7,000 actual egg cells arranged in a double row. The development of fertilization is similar to that of the frog.

METAMORPHOSIS takes about the same time as in the frog, the tail being absorbed in a similar manner; and very soon the young toads, like their parents, leave the water and distribute their forces over the countryside, wherever there is sufficient food for them to exist upon.

One extremely remarkable thing about the developing young toad after it has found a home for itself is the fact that it does not reach maturity until after five years of growth; this suggests that the possible age which an individual may reach is very great.

In the case of the midwife toad, spawning is somewhat different from that of either the common toad or the natterjack, and is particularly interesting. The female lays from twenty to fifty bright yellow eggs in a long string which the male (who is the real "midwife") entangles around his thighs. He then retires into a hole away from the water for about six weeks, until the embryos have reached the tadpole stage, when he goes back to the water and the tadpoles escape from the eggs.

'MIDWIFE' AT WORK

The female of the comparatively rare midwife toad lays her golden eggs connected in a string, which the male entangles with his legs (as seen in the photograph below) and pulls after him out of the water into a hole in the bank, where development proceeds for six weeks. Then he drags the hatching eggs back to the water.

W. S. Pitt

J. Clegg

'GOLDEN-BACK'

The natterjack toad is somewhat smaller than the common toad and its legs are proportionally shorter. The narrow yellow line which runs along the centre of the back is perhaps the most distinctive feature, and has suggested the local name—"golden-back." "Natter" comes from the Old English word for poison.

The food of the toad consists for the most part of insects both in adult and pupal form, though other animals are eaten, such as baby mice and spiders. The appetite of this animal is one of its most extraordinary features, for naturalists who have kept toads in captivity have observed that they will go on eating hour after hour as long as food is supplied to them. This characteristic is in accordance with the general appearance of the toad, for no one could look at the animal and not realize at once that it is a great eater.

TOADS spend most of their time lying quietly in a small cavity scratched out in the ground and known as a "form," but with the coming of twilight they crawl out and forage for themselves. The animal has a very well developed homing faculty, and although a single individual may have to wander a long way during the evening to find food, and however plentiful food may be in a certain region, the toad will never forsake its original form and will return there to spend the hot hours of the daytime whatever difficulties may be met with.

The common toad is found throughout Britain, but not in Ireland; the natterjack in most parts of the British Isles; and the midwife toad chiefly in Bedfordshire.

REARING TOADS AND FROGS

The rearing of toads and frogs from their spawn provides an interesting way in which to make use of an aquarium such as that described in the practical notes in page 136. The spawn should be collected in a jam jar and kept floating in pond water until actually tipped into the aquarium itself; it should not be allowed to get dry. While the eggs are going through the process of development before the arrival of the tadpoles, the water *must* be kept fresh

After about three weeks the tadpoles will begin to appear, and at this stage even greater care must be taken. They must be provided with a home where, as soon as they develop legs and arms, they will be able to crawl on to dry land composed of mossy rocks and damp soil. If careful watch is kept on them the entire process of gill development, growth of limbs, loss of gills and the final absorption of the tail will be seen without difficulty.

Toads can be tamed more easily than frogs and are particularly sensitive to any form of music. If reared in the manner described above, as soon as they reach maturity they should be removed to another and considerably larger aquarium where there is not only plenty of water, but also a sufficient amount of dry land on which they may hunt their prey and find for themselves suitable sleeping and hibernating quarters. If supplies of grubs and insects are provided in large quantities for the captive toad, it will very soon become tame and interesting experiments on its feeding habits may be carried out.

MICROSCOPIC MAKERS OF THE GLOBAL CRUST

CREATURES so small that they cannot, in many cases, be seen by the naked eye, and in all cases have to be seen through a microscope for their form and structure properly to be appreciated—yet these infinitesimal beings have, through the ages, built up huge strata of rock, the sedimentary covering of considerable portions of our world. The story that is told below, of the ceaseless rain of tiny shells upon the sea-floor, will be appreciated not only by the amateur microscopist, but also by the geologically-minded reader

THE formation of shells by certain of the protozoa is described in an earlier chapter (*see* page 194), where it is shown that these protective coverings assume forms of great range and variety. But, apart from the delight which they afford the eye of the naturalist, the animalcules might well be considered by many to be of no importance at all in the world scheme, while most would at first declare that though their structures may interest the zoologist, they could not conceivably have any but a comparatively negligible general effect. Yet it is true that these tiny animals, owing to their immense numbers and wide distribution, have an effect on the face of the land out of all proportion to their size, forming as they do whole chains of hills and deep and wide-spreading strata of rock.

We have seen (page 195) how certain protozoa, given nourishment and opportunity, will continue to reproduce themselves, by binary fission, indefinitely. It is clear, therefore, that in the huge areas of the seas and oceans these marine animalcules multiply exceedingly swiftly, filling the waters with their uncounted swarms in addition to providing food for higher forms of life. Where these protozoa possess shells, the shells will sink to the bottom on their death, and thus, since individuals out of the great swarms are continually dying, there is a steady rain of shells towards the ocean floor. In the more shallow parts of the seas, inshore, and on the continental platform, whither sand and silt are swept down by terrestrial rivers, the shells are submerged and lost in the mass of débris that is deposited on the sea-bed. In deeper waters farther out, however, where the water is free from pollution by the rivers, there is nothing to interfere with the deposition of these microscopic shells and there, year after year, century after century, epoch after epoch, the ceaseless rain of microscopic organisms continues, gradually forming thick deposits upon the ocean floor. When the sea-bed is raised, these deposits will be hardened into rock and will form enormous layers of strata.

There are two different types of these rock-forming protozoa : those that supplement their chitinous covering with an outer layer of calcium carbonate, and those in which the outer shell is siliceous. The former is by far the more important group, and is known as the *foraminifera* (Lat. *foramen*, small hole ; *ferre*, to bear) from the numerous small apertures in the shell through which the

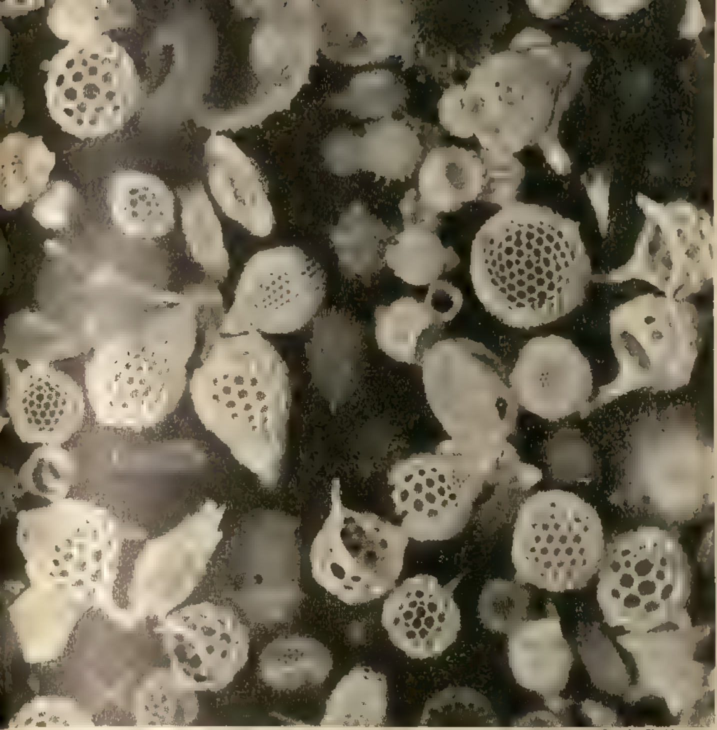
FORAMINIFERAL UNITS

Polystomella is one of the commoner foraminifera and may be found in our sea pools by the microscopist on the look-out for specimens. This photograph (× 35) shows the details of formation and the delicate structure of these minute shells.

SHELLS IN THE OOZE

Foraminifera may be dredged from most of the ocean floors. The shells seen here (× 100) were taken from the North Sea, thus proving that such deposits can be laid down in shallow water, and do not need abyssal conditions for their formation.

E. A. Botting



E. A. Bolting

UP FROM THE DEEPS

Radiolaria are nearly always found at greater depths than the foraminifera, as their siliceous shells withstand the pressure of the water better than the calcareous shells of the foraminifera, which crumble and dissolve. For this reason radiolarian deposits are usually supposed to be of abyssal origin.

rod-like pseudopodia of the protozoon project. In these the necessary calcium is extracted from the seawater, and is converted by complicated chemical changes into a lovely and delicate shell, pale pink or glistening white. The steady accumulation of these minute masterpieces forms a mud upon the sea-floor, which is dredged up today from the Atlantic Ocean and the North Sea. The Atlantic ooze contains a preponderance of one species, *globigerina*, and is therefore known as globigerina ooze.

Polystomella Among the Sand Grains

Of the many beautiful and varied shells of the foraminifera, one in particular emulates the shape and colouring of the pearly nautilus. Although it is sometimes difficult for the amateur microscopist to collect such specimens for himself, he may easily obtain sample slides from firms that supply microscopes and their impedimenta, and there is one form which is easily obtained; this is the form known as *polystomella*. Polystomella is not planktonic, but creeps about near the bottom in shallow water. In order to obtain specimens on a visit to the seaside, the microscopist should collect a piece of seaweed from the rocks near low-water mark and wave it gently to and fro in a saucerful of seawater; a number of small sand grains will be washed off and sink to the bottom. If the saucer is left undisturbed it will be noticed that some of the grains have apparently climbed up the sides of the saucer; these are not sand grains but are polystomella, and, if placed upon a slide and examined with low power, they will provide a sight that will well reward the microscopist for his trouble. He will see a coiled shell divided into chambers and approximating in form to the shell of the nautilus.

The foraminifera are of very ancient lineage. Small forms are found abundantly in the limestone rocks of the Carboniferous system, and have been obtained from the rocks of even earlier systems. The chalk cliffs of south-east England were almost entirely built up by accumulations of the small creatures which flourished and died millions of years before Man appeared on earth.

Radiolarian Makers of the Rocks

Of the two rock-forming protozoa mentioned earlier, the second group is known as the *radiolaria* (from Lat. *radiolus*, little ray). These form an outer shell by reinforcing their chitinous covering with a layer of silica. The radiolaria are pelagic drifters in the seas and oceans, but their remains are more frequently dredged from a greater depth than are those of the foraminifera. The reason for their preference for deep waters is that they are less numerous than the other protozoa and would be extinguished by the weight of numbers in waters of moderate depth; but in the abysses of the sea they are without rivals, for the pressure helps the seawater to dissolve away the calcium in the "forams'" shells, and the radiolaria alone are left to form a siliceous ooze.

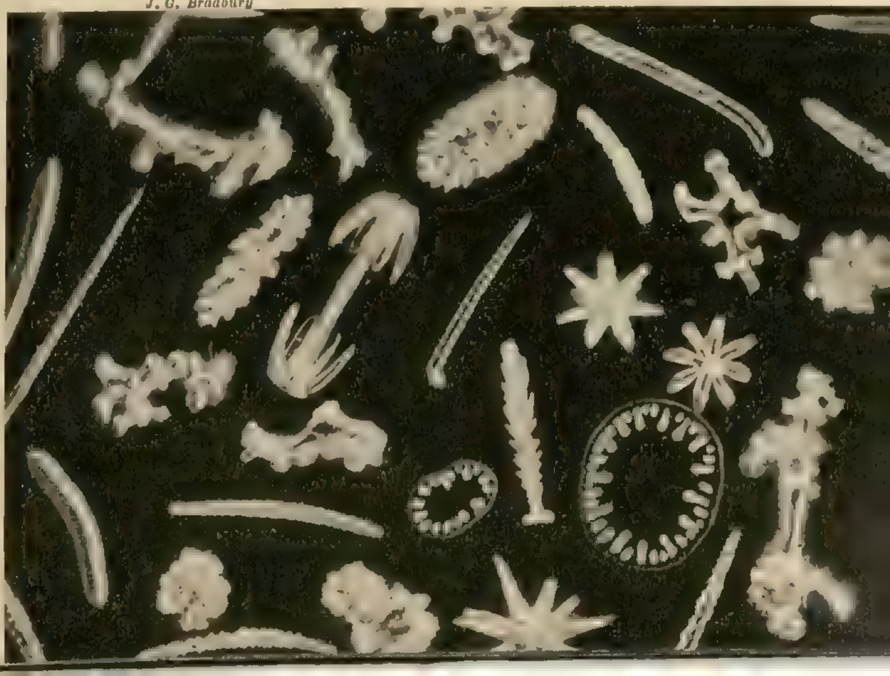
This second group of shelled protozoa have not so attractive a colouring as that found in the foraminifera, but their shells exhibit a delicate tracery in their framework which more than compensates for that loss. Where they occur as fossils in the rocks they are often associated with sponge spicules and the siliceous skeletons of other marine organisms, and may merge with them to form bands of flint or chert, these concretions often being due to chemical infiltration taking place after the ooze has been transformed into rock.

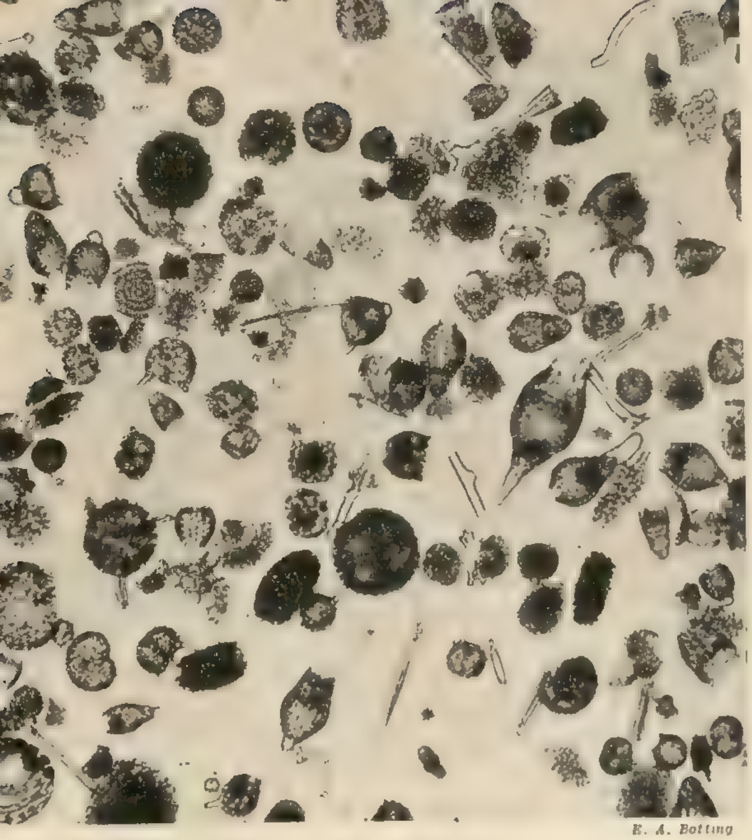
A third group of lowly organisms which, owing to their numbers, are of importance as rock builders comprises the diatoms. These small forms of vegetable life are present both in ponds and in the sea, and they may also add to the siliceous rocks, since they occur in such

SPONGE FRAGMENTS

Siliceous deposits, whether past or present, contain other forms besides radiolaria; they often include, e.g., sponge spicules—disintegrated portions of siliceous sponges' skeletons—such as are seen below. This photomicrograph (× 100) shows the attractive appearance and varied design of the tiny shapes.

J. C. Bradbury





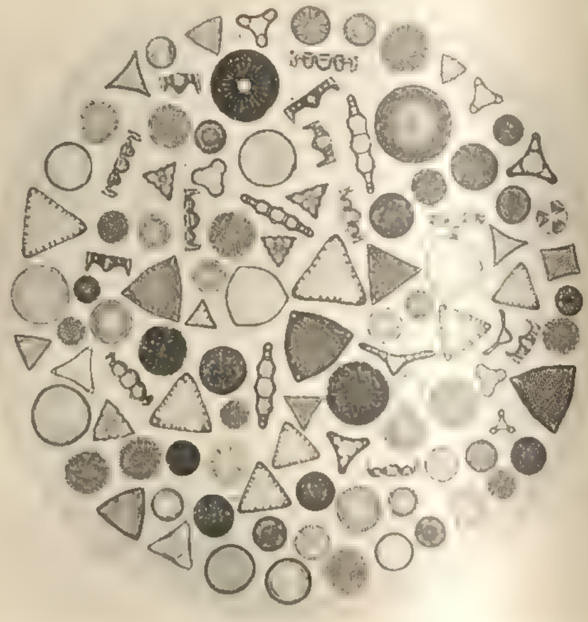
E. A. Botting

STRAIGHT FROM THE DREDGE

When first dredged-up the ooze does not always present such a pleasing appearance as is seen in the pictures in pages 446 and 447. This photomicrograph (× 100) shows what a radiolarian ooze looks like when first examined by the microscopist, yet even so, despite the shells' disordered array and indistinct outlines, their delicate structure is clearly revealed.

large numbers as to form a diatom ooze similar to the radiolarian ooze, but differing from it in the form of the small skeletons which compose it. Specimens of radiolarian or diatom ooze are best obtained from professional makers of microscope slides, though individual diatoms may be procured from stagnant ponds. Even more interesting are the rock sections cut from flint and chalk, which show the fossil protozoa to be closely allied to those living today. Slides of rock specimens are best obtained from an expert, but to secure fossil foraminifera from the chalk is a comparatively simple matter and one which may well be attempted by the amateur microscopist.

A visit to the rolling slopes of the Sussex downs or the white cliffs of the Dover coast will give some idea of the immensity of the numbers of protozoa that were necessary



J. G. Bradbury

DIATOM SYMMETRY

Oozes are also formed from the skeletons of diatoms, or unicellular plants. These diatoms have contributed to many of the flinty or siliceous oozes of the past which are now seen as beds of flint or chert. In this photomicrograph (× 65) the wonderful symmetry exhibited by these minute plants is [illegible].

to form the chalk escarpment; and the importance of these apparently futile creatures will be understood when it is realized that they also form a large part of the limestones and calcareous sandstones, and of the cherts and flints from which early Man carved his first crude instruments and weapons.

Revealers of Nature. 14

SIR E. RAY LANKESTER

In the title of his most famous book, Sir Edwin Ray Lankester defined the domain and forces of Nature as "The Kingdom of Man," and he devoted himself to pointing out the extent of that kingdom, urging its speedy possession by its rightful monarch and chronicling the slow progress in capturing the territory made by slowly-awakening Man. He did all he could to popularize science—to make scientific and, particularly, biological knowledge not the perquisite of a few brains, but the rightful inheritance of all. There must be many who owe their first glimpse of that mysterious country which we call Nature and its inestimably powerful forces to the weekly article contributed for several years by Ray Lankester to the *Daily Telegraph* under the title "Science from an Easy-Chair." These articles, collected in book form in 1908, 1910 and 1912, were important contributions to the scientific library of the man in the street. "Great and Small Things," 1923, was another work of the same type.

Popular as he was with the non-scientific public, Ray Lankester was not despised by his fellow scientists, as is sometimes the fate of those who attempt to make knowledge intelligible to the commonalty. Indeed, he was held in high esteem by academic scientists as well as by newspaper-readers. The son of a distinguished scientific writer, he was born in London in 1847, and from St. Paul's School passed through both Cambridge and Oxford. He made his first important discovery—of the first parasite ever found in the red blood cells of a vertebrate animal—in 1871, became professor of zoology in London University in 1874, and was elected a member of the Royal Society in 1875. He was later, 1890–1905, professor of comparative anatomy at Oxford; but possibly his greatest services to science and to the man in the street were rendered as director of the South Kensington Natural History Museum from 1898 to 1907, when he was knighted on his retirement. Here he carried out his own precept:

> It has become more and more a matter of conviction to me . . . that the time has arrived when the true relation of Nature to Man [i.e., biological science] has been so clearly ascertained that it should . . . form far more largely than it does at the moment the object of human activity and endeavour—that it should be, in fact, the guide of State government, the trusted basis of development of human communities.

Here speaks the true Darwinian, and Ray Lankester was, indeed, one of the most whole-hearted and ardent disciples of Darwin we have yet seen. Although he lived until 1929, when many modern discoveries had bade fair to undermine, or at least modify, the strict Darwinian and mechanical theory of life and evolution, nothing ever shook his faith in its truth and in its value as the basis for all political and educational activity. Though possibly obstinately wrong in detail, he was, nevertheless, generally right in principle, and much of the recent development in ordering our life scientifically aright must be attributed to the view of Man's kingdom first pictured by Ray Lankester.

FLORAL UMBRELLAS IN MEADOW AND HEDGE

A GLANCE at any of the photographs accompanying this chapter on some of the most frequently-encountered members of the Umbelliferae—umbrella plants—will show the aptness of the designation, for in all, to a greater or lesser degree, is present the slightly convex flower-head supported by a number of stalks radiating from the top of a stout central stem. It might even be argued, perhaps, that the shape and function of our umbrellas were suggested by these widely-distributed flowers

THE flowering plants comprising the important order Umbelliferae are numerous, and the majority of them are distinguished by their great size and uprightness, and by the masses of tiny white flowers which they bear. The pea family is represented by a larger number of species, at least in the British Isles, and so is the rose family, but many of the members of both these groups are so small and insignificant that no one except the naturalist who is especially on the look-out for them will notice them. The same cannot be said of the umbellifers, which obtrude themselves on our attention wherever they grow. Their white flowers are extremely small, but, being borne, as the name of the order implies, in an umbel, are noticeable for their numerical strength, for in this inflorescence the flowers are borne at the tops of a number of rays, all arising from the same point. In the case of a compound umbel each ray divides at its top into a number of smaller rays, which may divide in turn or, on the other hand, may bear the flowers.

Reference is made in the chapter on the daisy (page 427) to the fact that white is not attractive to insects, and it might at first seem strange that such a group as the umbellifers should have survived at all—let alone thrived successfully—when almost all its members have white flowers. The fact is that, since they have enormous numbers of these flowers, the flower-heads are so large and so numerous that they make up in numbers what they lack in individual attraction. Furthermore, the factor of length of contour, also mentioned in connexion with the daisy, plays an important part in the attraction of insects to these plants. The small flowers do not, as a rule, grow in a very tight, close head, but show a very large contour in comparison with the area covered by their petals, thus further increasing their powers of attraction.

Flowers and Seeds of the Umbellifers

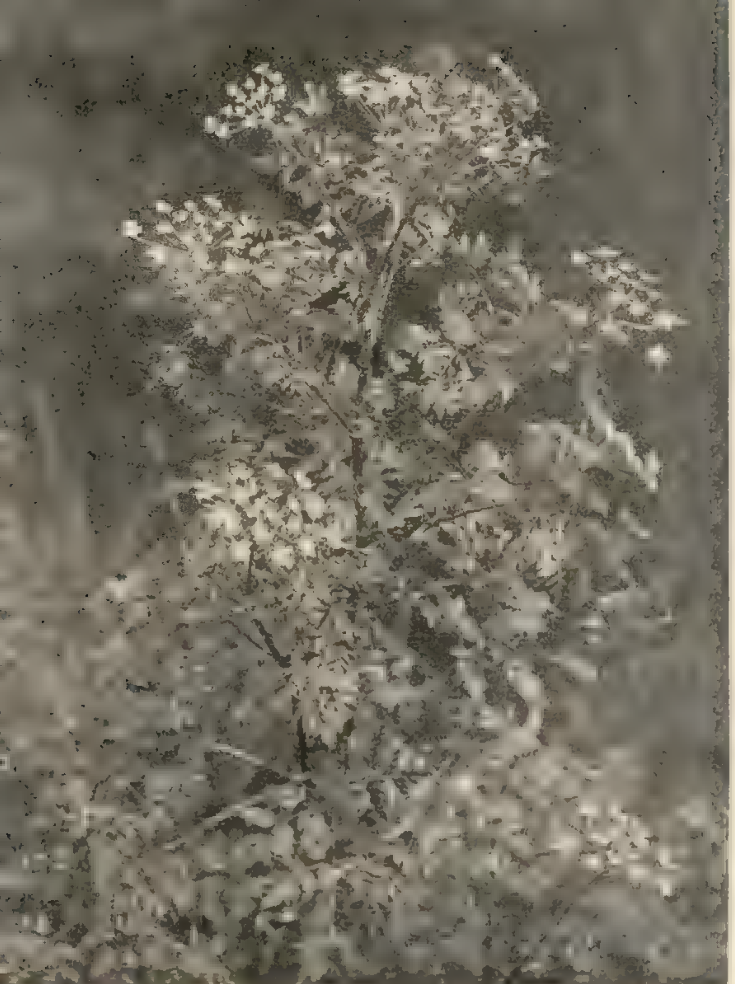
OTHER characteristics which help to distinguish the members of this order from those of any other group are concerned with bracts and seeds. Beneath each umbel, at the point of the departure of the rays from the stem, there is an involucre of bracts, which are known as general or partial bracts according to whether they are, respectively, at the base of the main umbel or at the base of one of the secondary or partial umbels. The seeds of umbelliferous plants are most curious. They are enclosed in a two-celled ovary, and this ripens to a fruit consisting of two carpels, each of which contains a single seed. The seed itself is equipped with a large, tough, albuminous body, which serves as its food supply in much the same way as the yolk serves the embryo chick in an egg. The outsides of the carpels are ornamented with a number of ridges, between which are often to be found cells containing a certain amount of oily matter. These features are essential to the welfare of the group, for the seeds are few in number and their chances of growth are increased by the provisions which help them to tide over a bad period.

One of the earliest of the umbellifers to flower is the wild beaked parsley. This is one of the commonest and most characteristic of the spring hedgerow plants, its flowers combining with those of the stitchwort, described in page 162, to delight our eyes long before any of the better-known flowers of the late spring and summer have done more than show their first leaves above ground.

PARSLEY IN THE WILD

The plant seen below, the wild beaked parsley, is one of the commonest of the flowers of spring and early summer. Its delicate leaves, tall stems, and umbels of very small white flowers are all typical of the order *Umbelliferae* to which it belongs.

H. Bastin



E. J. Bedford

DEADLY HEMLOCK

To the uninformed this plant looks much like any of the other umbellifers illustrated in this chapter, but it is one whose features should be learnt, for it is the poisonous hemlock. Purple-blotched stems, masses of finely divided leaves, and an absence of hairs are some of its distinguishing characters.

Its size and manner of growth make it easily recognizable, for it exhibits all the features mentioned above as characteristic of the order.

The height of the wild beaked parsley is anything from one to four feet. Its stems are thin and delicate; they bear large compound umbels of flowers, which are from two to four inches across, while the diameter of the simple umbels of which they are composed is about $\frac{1}{2}$ inch. The flowers themselves, which are white, are $\frac{1}{8}$ inch in diameter; there are five petals and five stamens, but the sepals are absent, as is often the case in umbelliferous flowers. The leaves are compound, being, strictly speaking, of the type described as pinnate; but they are so cut up that the adjective "fern-like" best describes their appearance. They are from five to ten inches in length, and their delicate form and bright green colour add as much to the charm of the wayside vegetation as do the flowers themselves.

A FEATURE by which the wild beaked parsley may be distinguished early in the year is the manner in which the umbels of flowers hang downwards, their heads bent, before they are fully open. At the base of each partial umbel there are about five reflexed bracts. The fruits, which in many members of this order constitute the best "identification marks," are smooth, and have a little beak that gives this plant its name.

The problem of classifying the umbellifers offers many difficulties to the beginner in botany, but one of its members, at least, can be easily identified. This is the common cow-parsnip, or hog-weed, which may be seen in summertime. It is a much stouter, coarser plant than the beaked parsley, and the stems are channelled and hairy. Its height alone, coupled with the very stout nature of the stems, makes it unmistakable, for this plant may grow to over six feet, and always towers above its neighbours in the field or at the wayside. The leaves are large and rough with coarse hairs, and they differ from those of the beaked parsley in that they are simply pinnate, the separate leaflets being serrated but not very deeply cut up. Both compound and simple umbels are found in the hog-weed, their respective diameters being about four inches and one inch.

Inflorescence of the Hog-weed

YET another character often found in this order is seen in this plant, namely, that the outer flowers of the umbel are rather larger than the inner ones; in the present case the outer may be as much as $\frac{3}{8}$ inch across. These flowers have their parts in fives, and the petals, which are very irregular in size, are usually two-lobed. The stems are branched, and the plant is further distinguished by its leaf-stalks, which enlarge at their bases to form wide wing-like organs. The latter serve as sheaths for the inflorescence long before it has grown or opened. In winter the stems of the hog-weed

R. B. Matson

TOWERING HOG-WEED

The names hog-weed and cow-parsnip, both applied to the plant that bears this fine umbel of flowers, would seem to imply that it is a favourite food of pigs and cattle. Its coarse stems, with the curious sheaths at the bases of the branches, are very characteristic, but its most noticeable feature is its height.

are among the most conspicuous features of the landscape, persisting—tall, upright and firm—for many months. Known to the country people as "kecks," or "kex," they are worthy of the especial attention of the naturalist, for they act as a winter refuge for many small beetles, other insects and spiders, and are also the permanent home of the larvae of some species.

Source of the Athenians' Poison

A plant of the umbelliferous order which has been famous from classical times is the hemlock, the plant from which the poison that formed the lethal weapon of Athenian law-givers was made. The scientific name of this plant is *Conium*, whence is obtained the name of the drug conine, which is made from the plant. Since hemlock is so dangerous a plant—a few drops of the juice may be poisonous to small animals—it is as well to be absolutely certain of recognizing it at sight. The stem is smooth and shiny, and is spotted and blotched with reddish-purple in a manner found in no other umbellifers; the leaves are completely smooth, while the bracts at the base of the partial umbels do not encircle the stems, but are all on one side. Apart from these points, there is little about the hemlock to arrest our attention. The flowers, which are white, are borne in the usual compound umbel, but the partial umbels are spread out far more than in the case of the hog-weed, so that, instead of one almost solid mass of flowers, there are a number of small clusters. The fruits of the plant are in pairs, the inner face of each one being flat, while the outer face is convex, the two together combining to make a rounded body. The outer faces are marked with thick, prominent ridges.

E. J. Bedford

UPSTANDING ANGELICA

The wild angelica is an umbellifer that is not so similar to its cousins as this picture might lead one to suppose. The flower-heads are rounder and more compact than in most species of the order, and the leaves are more simply pinnate than usual.

J. J. Ward

CARROT HEADS

The cultivated carrot is familiar to all, but few ramblers are acquainted with the wild variety, whose flower-heads are seen above. The way in which the rays of the umbel curve upwards and inwards provides a means of telling this umbellifer at a glance.

As the names of the beaked parsley and the cow-parsnip would indicate, several of the most familiar plants of the kitchen garden are members of the Umbelliferae; besides the parsley and parsnip, the carrot, for instance, belongs to this group. The wild form, from which the cultivated varieties are said to have been evolved, is, of course, very different in appearance from that which we are used to seeing in our gardens, for in the latter case it is never allowed to run to seed, or send up a main aerial stem.

For all that, the wild carrot is an easily recognizable plant, and one which every rambler should know. It possesses certain outstanding and distinctive features which obviate the difficulties of classification referred to earlier, and at the same time save us the trouble of having to go deep into the botanical side of its structure. To begin with, the stems of this plant are solid, and not hollow as in other umbellifers, and the leaf-stalks are splayed out at their junction with the stems, which they clasp. Next, the leaves themselves are very much more simply pinnate than in those species already described, consisting of a number of fine leaflets which are not serrated on their edges. Finally, the inflorescence, which consists of the usual umbel, is many-rayed, and the rays are very close

together, so that the flower head appears as one great mass of bloom. The central flower, or group of flowers, of this mass is very often red or pink, and the way in which the many rays of the head curve inwards when the flowers have died causes a saucer-like depression in the middle of the head. Beneath the head there is a ring of bracts, each of which is deeply cut into a number of segments. The seeds, too, are distinctive, being long and convex and armed with curved hooks, which enable them to cling to any passing object.

Wild Angelica of the Water Meadows

No part of the land is without its quota of umbelliferous plants. They flourish in the water meadows, and one of the most individual of the several large plants of this group to be found in wet places is the angelica. The stems are stout and furrowed and tall, with large, pinnate leaves whose leaflets are simple and serrated. The characteristic umbel is found, but the central rays are rather longer than usual, so that the flower head is rounded and convex; the flowers are often tinged with pink.

Several species of water dropwort are among the other umbellifers found in the meadows, and of these the commonest are the hemlock water dropwort and the common water dropwort. The latter, which, in spite of the epithet "common," is not so widely distributed as the former, earns its name because it grows in large masses and is more likely to attract attention than the other plant. All the water dropworts have white flowers, and all come into bloom rather late in the year, usually not before July. The leaves are simply bi-pinnate in the case of the common water dropwort, and in the hemlock water dropwort are broad, compound and with wedge-shaped segments. The former plant has only three or so partial umbels, while the latter's rays are numerous. The outstanding feature of the common water dropwort is the fact that the leaves and stems are hollow, consisting of little more than a number of very thin-walled tubes.

E. J. Bedford

AQUATIC ADAPTATION

The curious tubular leaves and stems of the water dropwort, a plant especially adapted to an aquatic habitat, make it easy to recognize, while the few-rayed umbels of flowers distinguish it from the closely related species in the adjoining column.

WATERSIDE MASSES

Hemlock water dropwort is the name of the plant seen in this photograph, but if it were altered to hemlock-leaved water dropwort it would be more descriptive. The leaves (poisonous, like the root and stem), and the many-rayed umbels distinguish it from the common water dropwort on the right.

E. J. Bedford

Both plants have ribbed stems, and the flowers are in small, rounded heads which are well separated, not forming a single large head (*see* the pictures in this page). Hemlock water dropwort owes its name to the highly poisonous nature of its leaves, roots and stems; the resemblance of the latter to celery has been responsible for many deaths. The leaves of the plant are rather similar to those of the true hemlock, so that if the plant were called hemlock-leaved water dropwort the name would be no less suitable. Further poisonous plants are described in a later chapter and a "practical note" gives advice on their identification.

WARBLERS OF THE HEDGE AND THICKET

MANY are the members of the warbler tribe—and well, indeed, that it is so, for we should soon note the deficiency if the countryside was deprived of their cheerful songs. Some are pre-eminently dwellers in the woodland—the willow and wood warblers, for instance, and the chiffchaff; others favour the watery places—the reed, sedge and marsh warblers; these are dealt with in earlier chapters. Yet others—those described in this chapter—are usually to be found fluttering among dense undergrowth, in coppices and thickets

ONE of the most fascinating features of bird song is the fact that when we begin to become really interested in the subject, we find that there are a large number of songs which we have heard, probably year after year, and yet have never previously noticed as separate songs; we have appreciated them as part of the general spring chorus of Nature, but not as songs characteristic of individual birds. Amongst such songs are those of some of our common members of the warbler tribe; they are, moreover, songs sung by birds which seldom catch the eye and which scarcely ever keep still in such a position as to enable us to examine them with a view to future recognition. Three members of the warbler tribe, the chiffchaff, the willow warbler and the wood warbler, are described in Chapter 7 (page 208), and two more in Chapter 12 (page 364). It is a large tribe, however, and those dealt with in this chapter are all important members.

Blackcap is a name that might justifiably be given to many birds, such as the bullfinch, the reed bunting and several of the tits, but it is as aptly descriptive of the warbler that bears it as it could be of any other bird. The black head is, in fact, the sole visible feature by which the naturalist can distinguish this bird from several of its near relatives—at least until he can call himself something of an expert ornithologist. The blackcap's voice, however, is absolutely distinctive; once one has heard the song, and discovered the singer's name, one is never likely to forget it. Of such quality, indeed, is this song that there are many who would place it above even the nightingale's; but it is erratic, and every individual does not seem to be gifted with the same silver voice.

It is difficult to give an adequate description of the blackcap's song. A few harsh, introductory notes are followed by a stream of silver music, which pours forth like a cascade, the individual notes falling over each other, rising and dying away, then suddenly ceasing, leaving us breathless by the completeness and unexpectedness of its finish. Not knowing what this strange songster can be, we stop in our walk and search, quietly and carefully, among the thick bushes in the hope of seeing it: then, just as we have espied a blur of brown wings in the thicket, the harsh notes are heard again, and we stand spellbound while the performance is repeated. The nightingale may be our finest songster and most perfect bird-musician, but surely there is no song so stirring or so thrilling as that of the blackcap. When, perhaps after a long wait and many anxious moments, we do at last catch sight of this silver-voiced

MATERNAL PLACIDITY

From the calm and contented attitude assumed by this female blackcap brooding on her nest, it is evident that she is quite oblivious of the photographer's presence in the near-by hide. Her fluffed-out feathers indicate that the nest contains not eggs but young birds.

F. Vear

E. J. Hosking

HOME IN THE HOLLIES

Built almost entirely of grasses of varying size, the blackcap's nest is very like the creations of others of the warbler group. The eggs, too, with their muddy ground colour mottled with darker hues, are of the type that most warblers lay, but the site of this nest, in a holly bush, is rather unusual.

songster, we must not expect to be rewarded with a vision of fine feathers, varied hues or striking colours. The blackcap is no exception to what is almost a rule, that the finer a bird's song, the duller its plumage. The black head is, as has been said, the sole outstanding feature, the dark colour also extending down over the nape of the neck. The back is greenish-brown, with darker tail and wing-tips, while the underparts are pale, shading from grey on the chin to brownish on the flanks and under the tail. The female has a brown top to her head, and is generally browner than her mate.

Firm Construction of the Blackcap's Nest

THE blackcap is the first bird to be described that makes what one might term a typical "warbler" nest. Situated in deep herbage, bramble bushes, thickets or evergreens, the nest is cunningly woven of grass and sedge, lined with finer grasses and perhaps a little hair. It is not a very neat structure, but for all its flimsy appearance it is firm. The eggs, four or five in number, are rather dark, usually yellowish or reddish white with thick mottlings of reddish-brown. Like most of our warblers, the blackcap is a migratory bird, arriving rather later than the chiffchaff and willow warbler, in April. Many of the individuals leave us in September, and the rest depart not much later in the year.

In Chapter II (page 331), the irrelevance of the name hedge sparrow for a bird that is neither a sparrow nor particularly addicted to life in hedges is pointed out, and the name garden warbler is almost as absurd a label for the bird which we are about to describe. Although it is a warbler, it has no especial connexion with gardens, being even less likely to be seen in such places than is the blackcap. The garden warbler is a bird of the deep woods and thickets, where the undergrowth is dense, whereas the blackcap is fond of the open, and is more at home in the hedgerow than in the woodlands.

As regards its plumage, the blackcap may perhaps be thought rather dull, but for sobriety of colouring it cannot compete with the garden warbler. All that can be said about this bird's plumage is that it is olive-brown above, lighter below, and that there is a pale stripe running above the eye. In length the garden warbler is 5½ inches from beak to tail, being thus distinguished from the whitethroats (described later in this chapter), which it otherwise resembles. Its voice, however, more than redeems the impression of dullness conveyed by its appearance, for this is another bird that many observers would put forward as a claimant for the laurels usually given to the nightingale. Like the blackcap, the garden warbler sings during the daytime; consequently it has none of the romantic atmosphere in which the nightingale revels to help its song. Sheer merit focuses our attention on this bird, and sheer merit holds us and makes us

W. S. Berridge

NIGHTINGALE'S RIVAL

The blackcap, though less famous than the nightingale, is a magnificent songster, and some would say gives a superior performance. The cock bird seen here has the black head that gives the bird its name, in contrast with the browner colour of the hen bird pictured in page 453.

wait for more when the song is over. It is a longer song than that of the blackcap, but in other respects very similar, and although it does not often produce notes of such purity, it is little, if at all, inferior in execution and in the pleasure that it gives. It has been observed that the two birds seldom inhabit the same wood, but when they do, only the length of the song is a safe means of telling us which of these two birds is providing the silvan concert.

The nest of the garden warbler is of the same type as that described for the blackcap, possibly rather more frail, and, according to many authorities, usually nearer the ground, though the general situation is similar. Both cock and hen bird work at building the nest, and both may also be found sitting on the four or five eggs, which are whitish with blotches varying from reddish-brown to greyish-green. A further point of interest is that a pair of birds may experiment with several nests before finally finishing one and making it their home; why they do this is not known.

E. J. Hosking

SAFE THOUGH SHALLOW

This remarkably shallow nest, that of a garden warbler, is quite safe for all its apparently flimsy construction. The heads of the youngsters, upraised in the quest for food, show above the rim of the nest, but the parent bird seems to be taking very little notice of their clamour.

Two other warblers that the rambler is sure to come across frequently are the greater and lesser whitethroats. Both these birds are smaller than either of the two preceding, for, although the greater whitethroat measures the same from beak to tail as the garden warbler, it has a much longer tail, and consequently a shorter body. The lesser whitethroat is a rather smaller bird than any of the other three. Neither of these birds can compare with the garden warbler or the blackcap when it comes to singing, but they both sing frequently—in fact, almost insistently—so that they force us sooner or later to notice them.

The greater whitethroat, which is perhaps more aptly called the common whitethroat, since it is very little larger than its lesser relative, is one of our commonest birds, and is also one that passes unnoticed even when it lives quite close to human habitations. Its habit of creeping among the dense vegetation at the roadside has earned for it the country name of "nettle-creeper." Most at home amongst the tangled herbage of an ill-kept hedge or the bramble thickets of rough common land, it spends most of its days out of sight among the leaves and stems, coming to the surface from time to time to fling itself into the air after a passing insect.

E. J. Hosking

DEEP IN THE BUSHES

The nest of the lesser whitethroat differs from that of many warblers in that it is seldom on the ground, and often quite high up in some thick, tangled mass of bushes. That seen in this photograph is deeply hidden in the herbage, and is obviously of the same type as that of the blackcap in page 454.

Varied Notes of the Whitethroat

On these aerial excursions the whitethroat utters its very characteristic song, a jumble of notes of varying purity and sweetness, sometimes harsh, sometimes pure and lovely. It sings, too, during its travels among the bushes, and if we can get near enough to watch it, we see the bird's white throat swelling in song. Besides its song, the bird has a very characteristic warning or alarm note, transcribed as *churr*, which we hear uttered repeatedly when we are approaching the "danger zone" near the nest.

F. Jefferson

FEATHERY SUNSHADE

This remarkable photograph shows the way in which a female greater whitethroat succeeds in sheltering her brood, exposed to the direct rays of the midday sun. By raising herself off the nest she allows a breath of air to cool them, while at the same time her body provides welcome shade.

Built in the depths of a bramble bush, nettle bed or mass of weeds at the base of a hedge, the nest is made of fine roots and grasses, and is often lined with hair. The eggs, four to six in number, are laid towards the end of May, although the bird is one of our earlier arrivals in spring. They are greenish with grey spots and blotches, the markings being smaller than in those of the two birds whose eggs we have described above.

The whitethroat's head is grey, and so are the tail coverts, while the back is warm grey-brown and the wings are red-brown. The underside has a warm, almost pinkish tinge and the throat is conspicuously white. The outer tail feathers have white margins.

The last of these common warblers, the lesser whitethroat, has a grey back, tinged with brown, and some of the wing feathers are quite grey, although otherwise they are brown. The underparts are white, except for breast and flanks, which are pale brownish. This bird is fond of thickets and remote woodlands, and is more partial to trees than herbage. The song is very distinctive, consisting of a soft twittering, then a low, almost inaudible warble, and a final loud, metallic rattle. This last phrase is all we can normally hear of the lesser whitethroat's song, the prelude being uttered so softly that we have to get very close to appreciate it.

M. H. Crawford

HOUSE FULL

There is certainly no more room in this greater whitethroat's nest, for the five fat young birds completely fill it: when the time comes for them to fly, the nest will be flattened almost to a platform. As yet, however, the youngsters are only half-fledged.

Choice of nesting site is another point in which the lesser whitethroat differs from its near relatives, for it prefers a high hedge, a tall patch of brambles, or a thick tree in which to make the usual flimsy structure of grasses and roots. The eggs are creamy, with brown or greyish spots and markings.

HOW TO RECOGNIZE BIRD SONGS

In the practical note in page 409, it is pointed out that the correlation of plumage with the singing habits of a bird will often enable us to distinguish between two very similar species, or perhaps, if we are so fortunate, prove to our own satisfaction that we have "discovered" a rarity. To give an example of the former use of song, one obviously quotes the case of the chiffchaff and the willow warbler, two birds that can really only be told apart by their very distinct songs. Again, the differences between them and the wood warbler are also not very great, but the song of the latter bird is absolutely unlike any other song we are likely to hear in the woods. In a bad light we may be unable to distinguish birds that normally we could easily tell apart, but once we hear their voices, our doubts are set at rest.

The wood warbler is quoted as an instance of a bird whose song is completely diagnostic; another, of course, is the nightingale. When we come to the birds described in the chapter above, we find that song is once more a most valuable aid to identification, especially since the birds in question spend the greater part of their time hidden in the tangled masses of herbage and brambles at the bases of the hedgerows. The songs of greater whitethroat, garden warbler and blackcap can all be picked out with practice, but if we cannot be quite certain, a glance at the bird, the reward of perhaps many minutes' waiting, will serve to confirm our suspicions. The features by which the blackcap and whitethroat have earned their names are easily discernible if we can once catch sight of the bird, and if they are absent, then the garden warbler is indicated. Again, if we hear a song that rather reminds us of the whitethroat's, but is uttered by a similar-looking bird in a woodland habitat we can say with safety that the singer is a lesser whitethroat. A further instance of the way in which song aids plumage in bird identification is provided by the marsh warbler. This bird in many ways closely resembles the reed warbler, but when it sings the marsh warbler gives itself away, for the songs of the two warblers are utterly dissimilar.

MIDSUMMER'S EXPRESSION IN THE RURAL SCENE

MIDSUMMER DAY is in the nature of a misnomer, for many more weeks of summer remain after it than have gone before. It really marks not the middle of summer but the beginning of high summer—the period when the increasing and long-continued heat has brought every tree and plant into full bloom, has stimulated the creatures of the open into feverish activity, and has aroused in Man thoughts of holiday-making joys

SUMMER is here. The countryside has lost the fresh and brilliant greenery of spring, that brought gladness to our hearts after winter's long and gloomy reign, but the deeper-coloured and more mature raiment with which it is now clothed fully compensates for what it has lost in the way of delicacy. The hedgerows no longer display the glorious whiteness of the May, and many weeks must still elapse ere the autumnal berries impart to the roadsides a fringe of crimson. Yet in their place what a wealth of loveliness is ours! The pink and white of a myriad roses, for instance—roses whose beauty leads us to forget the underlying thorns that remind us with their presence when we try to pick a blossom or two from the hedges. Along the rough herbage that borders the roadsides the great white masses of the umbellifers, a group most typical of summer's flora, shine from their frond-like, dust-laden leaves. Herbage and hedge alike have already sheltered the nests and eggs of many sweet songsters, but even now parents' anxious cries betray the presence of their fledgelings. If we pause awhile and watch we may see them busily engaged in the never-ending task of collecting insects for their hungry brood, and from the direction of their journeys we may be led to a discovery of the nest, now partly flattened by reason of the nestlings' size, though the youngsters are still unable to forage for themselves.

Summer Scenes on Bank and Stream

Now the riverside holds for us many attractions that have been lacking earlier in the year. In the cool shade of the overhanging alders we may tie up our boat and laze the hours away, sleeping or fishing or just sitting in semi-somnolence, watching the endless play of eddies, the swaying water-weeds. Along the stream comes a proud mother moorhen, her woolly, black family crowding along in her wake—for, though tiny, they can swim almost from birth. Plop! and a great, fat, fly-fed trout rises, scattering the little fleet of chicks, while the parent, succumbing to the dictates of her temperament, takes to the air and clatters into the reeds. Among these reeds, too, we may hear the continuous twittering of the reed birds, for the reed and sedge warblers are seldom silent, and their chattering is one of the pleasantest and most soothing of all summer sounds. Gliding on the breeze, a swallow skims the surface of the stream, snatching a slow-winged alder fly from the very jaws of the fat dace lurking beneath the surface. As the soft breeze rustles the rushes a little swarm of flies, drowsy and taken by surprise, are scattered over the water, the line of rippling "rises" downstream showing that there are plenty of hungry fish waiting for just such an "accident" as this.

The bird-lover has not so much to attract him now that Midsummer Day has passed, for the foliage, now so much thicker than in the springtime, makes it hard to pick out and distinguish the feathered shapes. The period of greatest song is over, too, and many of our birds are silent by this time. For the

SUMMER'S BOUQUET

No flower is more characteristic of summer than the wild dog-rose, whose wide pink or white blooms decorate the hedges during that favoured season. The spray seen in this photograph has a delicate beauty unusual even in this plant, the leaves and the branch form combining to make an altogether lovely whole.

J. Bedford

CAMPING JOYS

Nowadays, all classes of the community, particularly young people, have learned to appreciate open-air holidays, and every year a multitude of men and women spend a few days or weeks in close contact with the countryside. Here is a boy scouts' camp set in a mountain-rimmed valley in Snowdonia

entomologist, however, be he the boy with a butterfly net or the more serious naturalist in search of rarities, there is an ever-increasing amount of material to be sought. Most of our native butterflies are on the wing by June or July, though in the case of some there is an interval during which larvae, and not adults, will be found. Insects that have been seen in large numbers in spring have laid their eggs and died, but the little larvae swarming on the grasses and plants by the wayside and in the meadows will produce a plenteous brood in the later summer and autumn. Perhaps we can forestall Nature by collecting the caterpillars and rearing them quickly—forcing them, so to speak—and thus we may manage to secure three broods where Nature has to be content with two.

THE surface of a well-worn, sandy path is one of the entomologist's happiest hunting grounds in midsummer. There he may see the little black holes that are the entrances to the burrows of many of our most fascinating forms of life. There may be found the larvae of the tiger beetle, while the adult beetles, coated in glistening green, scamper along the path before us. The solitary wasps and bees, too, are busy stocking their subterranean burrows with luscious caterpillars or flies—meat frozen by a sting—as provision for their hungry young. The hive-bees are yielding abundant honey for their owners; and now, too, we may expect the first visits from those disturbers of alfresco meals, the wasps. Yet they are among the most maligned of insects, for, if allowed to go unmolested, they will sting no one. Indeed, the wasps might be regarded as being amongst our most useful friends, for they are very adept at killing house-flies and bluebottles, and even aid the gardener and fruit-grower by carrying off large numbers of noxious caterpillars.

To the farmer, every season has its round of duties, and each has its own importance. There can be no doubt, however, that summer is the one that may most surely bring him disaster or success. By now he can tell, from a tour of his crops, whether this will be a good or a bad harvest—provided always that there are no sudden

thunderstorms, no summer deluges, to lay low the straw and rot away the ears. This, too, is the season of shows, and wherever there are beasts whose points or whose pedigrees suggest a chance of a prize, there will be anxious watching for days and nights before the great day of competition comes.

The fruit-farmer is concerned with even more urgent matters, for his bush-fruit is ripe and enemies are already among the plums and cherries. Oftentimes in blind hatred of the birds that visit his orchards, he may mistake friend for foe, and many a small bird has paid the ultimate penalty for an uncommitted crime. Of the birds that visit the orchards, as many species are concerned with the fruit-grower's insect enemies as with his fruit—but all too seldom he is unaware of this, and tits and warblers and finches may be trapped or shot down, to lie beneath the trees in the company of the jays and blackbirds that are really to blame for the raids on the orchards.

Subjects for the Angler's Studying

MIDSUMMER is perhaps a slack season for the angler—at least, if his sole concern is the slaughter of fish, for the trout will not rise in the hot, dry weather, and the coarse fish are only just in season and as yet neither game nor plump. But if he be content to sit on his camp-stool, or wander about the bank, lazily making an occasional cast, he will see more of Nature now than during the more profitable—speaking piscatorially—times of March and October. The birds of the waterside will always provide amusement with their antics among the reedy jungle, and the flies and other insects of the waterside are in themselves worth many hours of study. The plants of the water meadows are among our loveliest; and the great yellow flags—wild cousins of the garden irises—still brighten the edges of the stream, their colour enhanced by the gauzy sheen of the dragon-fly that chooses them as a resting-place.

As the summer days lengthen, the rambler, be he professed Nature-lover or not, comes into his own, and every week-end the choicest camping sites are patched with the green and white of tents, while the thin blue spire of smoke tells of a meal frying over the fire of sticks.

"Hikers"—ugly word but expressive—will be ever more in evidence with the coming of the generally-recognized holiday months; and wherever we go, on the moors of the West Country or the Downs of the south, among the mountains of the Lake District or Wales, in Shakespeare's Country and the Welsh Marches, in the Highlands and the verdant south of Ireland, we may be sure of meeting sturdy, sun-bronzed men and women, dressed in the minimum of costume and with haversack and camera slung across their backs.

"Back to Nature" is the ardent wish of all, now the summer has really come, and only the pleasures of an open air life are apparent. After the long weeks of hard and confined work in shop or office or factory, it is not to be wondered that all who can, hasten to seek the cool shade of the beech wood, stretch at ease in the long grass, bathe their tired limbs in the waters of river or lake—in a word, taste once again the joys of the summer days that, despite their full complement of hours, are to the holiday-makers all too short.

HAYMAKING IN THE SUN

Getting in the hay always makes an idyllic scene, and such photographs as this might be multiplied a thousand times during an English June. Hay and haymaking is the subject of a special chapter in the "Crops of Our Countryside" series (*see* page 513).

Photo, The Times

ALL THAT IS LEFT OF BRITAIN'S VOLCANOES

MILLIONS of years ago the flames of raging volcanoes lit up the night sky over what was to be Britain, and vast streams of lava were belched forth to become incorporated in the landscape. Today there are many relics of this vulcanic period to be found by the discerning in our peaceful countryside, but the volcanoes themselves are dead—or, remembering geology's time-scale, should we say quiescent?

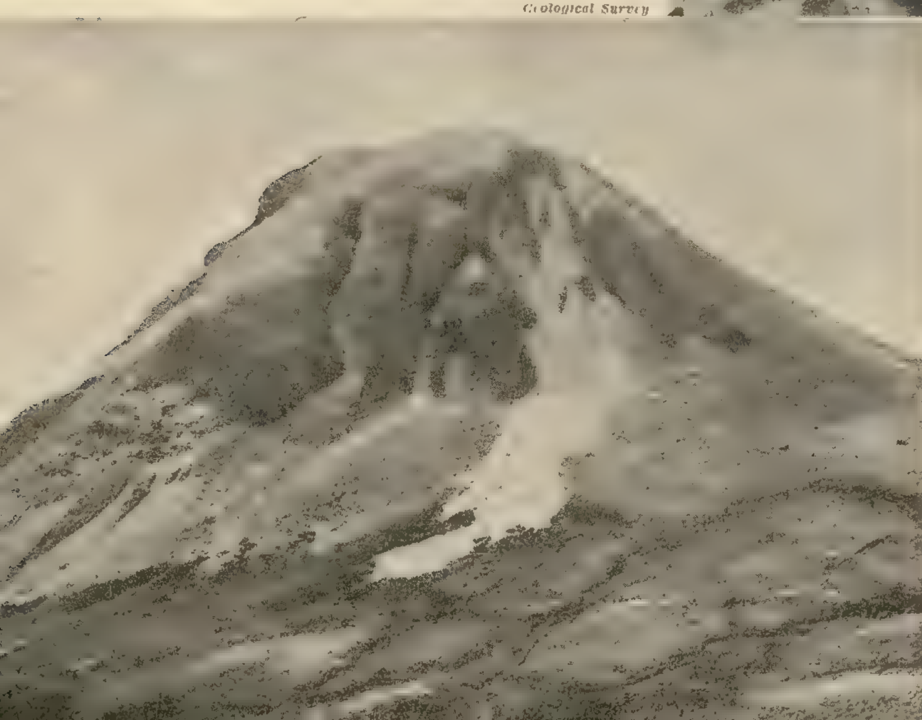
THERE is a peacefulness about the British Isles which has become proverbial. The climate is temperate, the people are reputed to possess an even and unexcitable temperament, and the land itself is undisturbed by destructive earthquakes and eruptions. But such tranquillity has not always been our island's lot, for at one time it was the focal point of violent seismic and volcanic activity, shaken by earthquakes and covered by vast outpourings of lava, the signs of which are patent in our rocks.

In the fourth chapter of this series (page 218) is described the way in which earth movement has twisted and folded the rocks, and we know that many of the mountains of the Lake District are built up of volcanic ash thrown out by craters that have long since disappeared. These outbreaks of volcanic activity were spasmodic, and long quiescent periods intervened. Thus the Ordovician period (possibly 300 million years ago) was characterized by intense volcanic activity, during which the hills of the Lake District and of Snowdonia were built up. After a period of quiet, volcanoes once more erupted in the Devonian era, this time in Scotland, and continued intermittently throughout the Permian-Carboniferous period, when fresh outbreaks occurred in Devon and Cornwall. Thus periodic vulcanicity marked the whole of that long epoch which is known to geologists as the Palaeozoic era. The Mesozoic era, which begins with the close of the Trias, or transition period, was one of quiet, and during that long period the giant reptiles flourished and the first mammals made their appearance on the earth. So long was this dormant period that it might well have seemed that such violent phenomena belonged to the past and that the volcanoes were finally extinct.

But this was not the case. In early Tertiary times (possibly 30 million years ago), before Man had appeared in the world, earth movement of a violent sort and on a large scale was widespread. During this time nearly all of the important mountain ranges of today—such as the Alps, the Himalayas and the Rocky Mountains—were built up. These seismic disturbances were accompanied by fresh volcanic outbreaks, which in the British Isles took the form of fissure eruptions, when large cracks opened to extrude lavas which spread out over a large area. In addition, there were smaller

LAVA PILLOWS

Much lava was extruded in Ordovician times. This photograph, taken near Ballantrae in Ayrshire, shows a sheet of ancient lava that while it was still in a molten state met the sea; the proof of this lies in the shape of the lava sheet (pillow lava) and the marine fossils it contains.



VOLCANIC VESTIGE

The relics of volcanoes that still exist in our islands today are chiefly the lava plugs that once filled the necks or vents. When the volcanoes themselves were eroded, the plugs remained, comparatively small volcanic relics, standing up as conical hills. This example is Dumgoyne Hill, near Stirling.

Geological Survey

craters and local foci which aided in the general distribution of the molten rock. The area of this outbreak was a large one, extending from the islands of Mull and Skye, the west coast of Scotland and the north of Ireland, through the Faröes, to Iceland, where the geysers show that volcanic activity is not yet altogether extinct.

SNOWDON'S ASHY SLOPE

Many hills look like volcanoes, but their appearance is deceptive. This photograph shows Snowdon, which, though it is mainly composed of volcanic ash and tuff, was itself never a volcano. As we see it today it is probably only a fifth of its original height.

SINCE there has been so much volcanic activity in the past, it is obvious that its effects must be evident in our landscape today. It is true that signs of past and vanished volcanoes are plentiful in the British Isles, but the enthusiast must be careful not to be misled by the appearance of every cone-shaped hill into assuming that it is an extinct volcano. There are in England no volcanic hills and craters similar to those found in Auvergne in France. Weathering and erosion have worn down the lavas, tuffs and ashes, so that nothing of the original forms has been preserved. Those cone-shaped hills, with hollows in their flanks that look so much like explosion-craters, owe their shape to glacial action, and though the rocks which form the hills may have cooled from the molten state, the hills themselves were not volcanoes. The truth of this will be realized more fully when it is remembered that Snowdon, which is built up of tuffs and ashes, had once five times its present depth of rock, most of which has been worn away in the course of time.

The evidence of past volcanic activity lies mainly in the substance of the rock itself. Many of the mountains of the Lake District, such as Great Gable, have been built up from volcanic ash, bedded and hardened, while the basaltic plateau of Antrim and the western islands of Scotland are composed of lava extruded from deep fissures. But there are yet other signs of an eventful past.

In some parts, where an ancient volcano once dominated the country, the outer cone and all the heaped-up ash have long since been worn away, leaving the neck or pipe outstanding. The reason for this is that the neck was once filled with the molten lava that welled up through this narrow passage to bubble and simmer in the crater. The molten rock in this neck cooled more slowly than the extruded lava, and so formed a harder, more compact

Geological Survey

EDINBURGH'S VOLCANO

The lion-shaped hill known as King Arthur's Seat, overlooking Edinburgh, is composed of two ancient volcanic plugs—relics of volcanoes which were active in Carboniferous times. The rocks present are mainly basalt and tuffs, weathered by the ages.

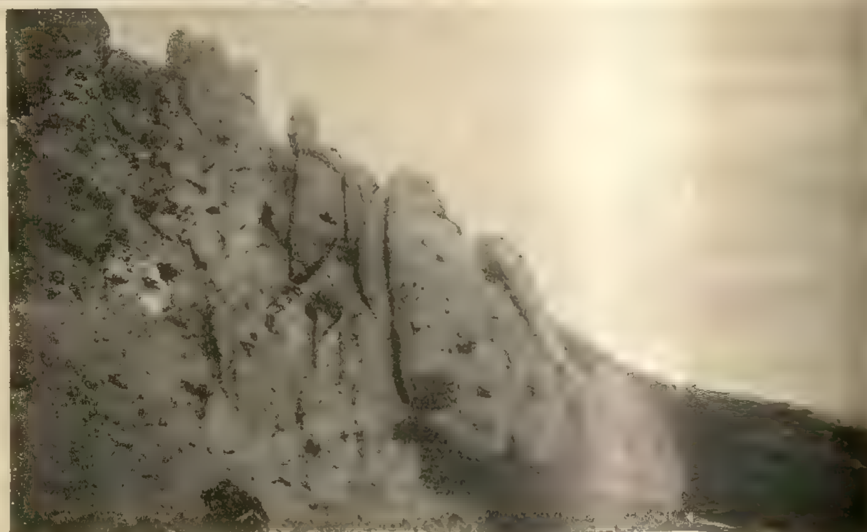
and the most notable example in Great Britain, the great Cleveland Dyke, has a total length of some 190 miles.

In other places there may be found lavas which while still in a molten condition flowed down to the sea. The effect of the sudden cooling by the sea broke up the lava sheet into rounded hummocks, forming the so-called pillow lava.

Signs of past volcanic disturbance are thus abundant in our islands. The last lavas cooled long before Man had appeared, but the interval of quiescence that coincides with, or, possibly, permits Man's existence, is but a short gap in the long history of our landscape, and those who know the past geological history of the British Isles would not, perhaps, care to predict that they are safe from a recurrence of devastating volcanic upheavals.

rock, which stands out in the form of tall bosses of rock when the surrounding material has been worn away by weathering through the ages.

Other signs of subterranean upheaval are "dykes" and "sills," which are of common occurrence and wide distribution throughout our islands. Dykes, as their name implies, are vertical or nearly vertical intrusions of lava that cut through all the pre-existing rocks and may often be traced across country for many miles. Sills are horizontal, or nearly horizontal, intrusions of igneous rocks, and are often found in between the bedding planes of sedimentary rocks. They may be differentiated from lavas that were deposited and interbedded with the sediments by the fact that they cut across the bedding planes and may be seen to pass from one to another if they are traced sufficiently far. These dykes and sills often extend for long distances across country. Thus, for instance, the great Whinsill can be traced for eighty miles from the Pennine Chain to beyond Farne Island,



LAVA FORMATION

Here we have a close view of a portion of one of the Scottish volcanic necks. Note particularly the darker-coloured fragments embedded here and there in the finer matrix of the lava, and the peculiar manner in which the rock has weathered.

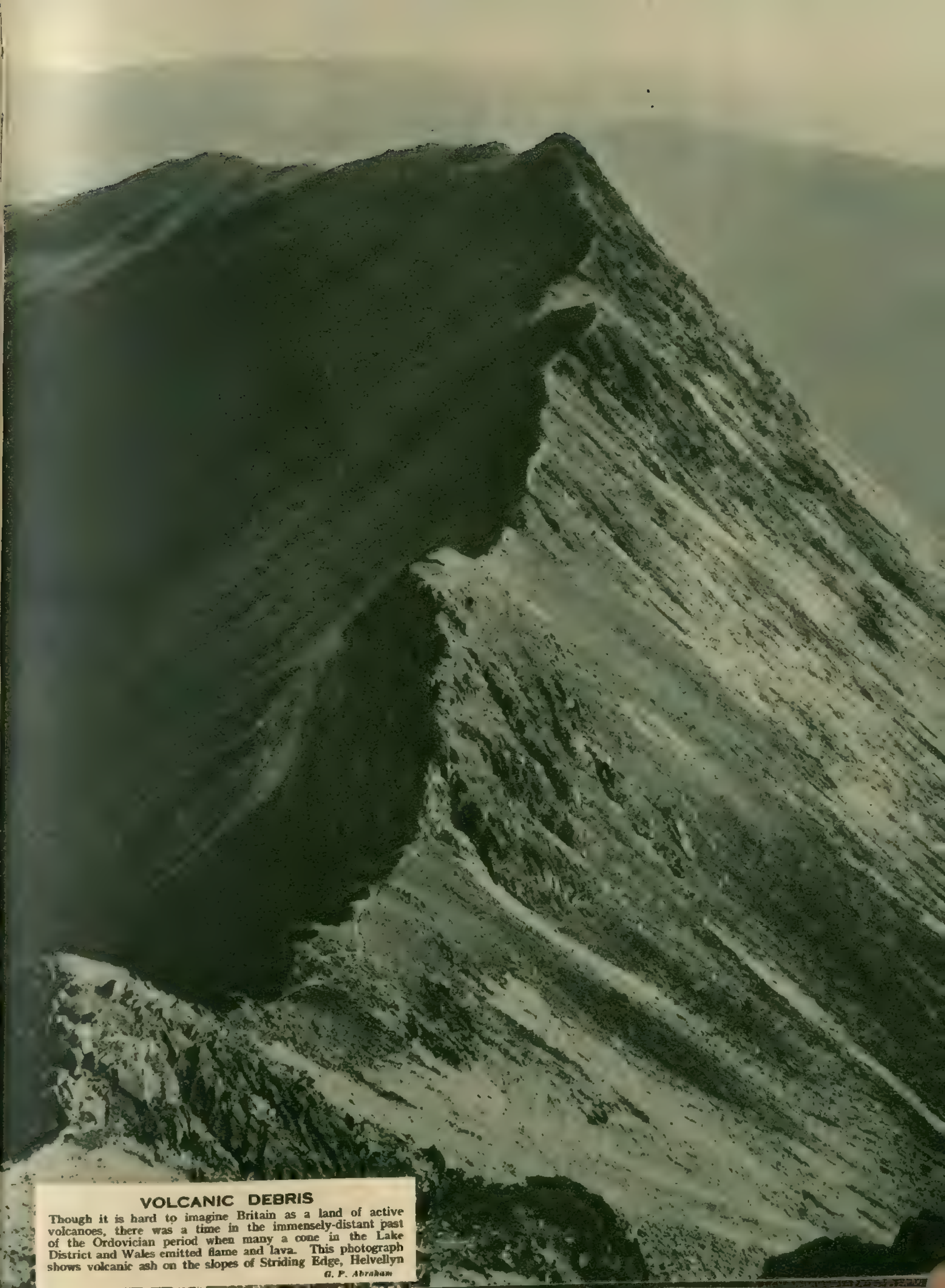
HINTS ON VOLCANO STUDY

Volcanoes have left little evidence in Britain of their past activity. The cone-shaped hills that may be seen in many parts of our islands have usually no connexion with vulcanicity, and seem to have adopted their shape perversely in order to mislead the enthusiastic amateur geologist. There are, however, a few real "plugs" formed from the lava that cooled in the neck of the volcanoes. A noticeable example of such a plug is that of King Arthur's Seat, Edinburgh, and those who have the opportunity should study this remnant of the past with care. Many people mistake the hollow cavities in glaciated districts for ancient craters, but the amateur geologist should be able to avoid this trap; there are no volcanic craters existent in Great Britain today. Apart from plugs, the evidence of volcanic activity rests chiefly on the nature of the rock. The molten material cooled and formed the rocks which are known to us as basalts and rhyolites. Sometimes, when the molten material cooled quickly and at the surface, the resultant rock was glassy, such as obsidian and pitchstone, and these rocks when examined often show "flow structure," that is to say, the rocks themselves show the direction in which the molten rock flowed.

Where to Find Volcanic Ash

Volcanic ash is very common in certain parts, particularly in Wales and the Lake District, where it may be seen as well-cleaned slates, and forms a great bulk of the rock. The nature of the rock in the plugs themselves is also interesting, for it is usually composed of a coarse-grained rock, often containing fragments of rock that fell into the molten lava. Lava is also solidified in the vast multitude of dykes and sills which intersect the rocks. It is well worth while examining these and noticing especially their line of contact with the surrounding rock, which is nearly always burned and metamorphosed. These dykes and sills always accompany volcanic activity. The most remarkable dykes in Britain nearly all belong to the middle of the Tertiary period, and are particularly abundant in Scotland.

The geologist may regret having no extinct craters to investigate, but there is plenty of evidence which he may examine with a view to reconstructing the volcanic past of Britain.



VOLCANIC DEBRIS

Though it is hard to imagine Britain as a land of active volcanoes, there was a time in the immensely-distant past of the Ordovician period when many a cone in the Lake District and Wales emitted flame and lava. This photograph shows volcanic ash on the slopes of Striding Edge, Helvellyn

G. P. Abraham

J. Dixon Scott

SUMMER IDYLL

This photograph is full of suggestion of the English countryside in high summer. Sunshine pours through the interstices of the leafy roof, and the ripening grass shimmers in the heat. The foliage is in its full glory and though we cannot see its colouring we know that it is dull green and covered with dust. Then the horses—the one, glossy with sweat, slaking its thirst in the stream, and the other in sleepy patience waiting its turn—and their attendants are quite in keeping with the scene

E. J. Hosking

WARBLERS' BOWER

This delightful study in avian domesticity represents a family of garden warblers in and about their shallow nest of grass, set deep in a bramble thicket. As is pointed out in Chapter 15 of the series "Our Birds and Their Eggs" (page 454), the term "garden warbler" is something of a misnomer, for the bird has no special association with gardens but is a denizen of the woods and dense thickets

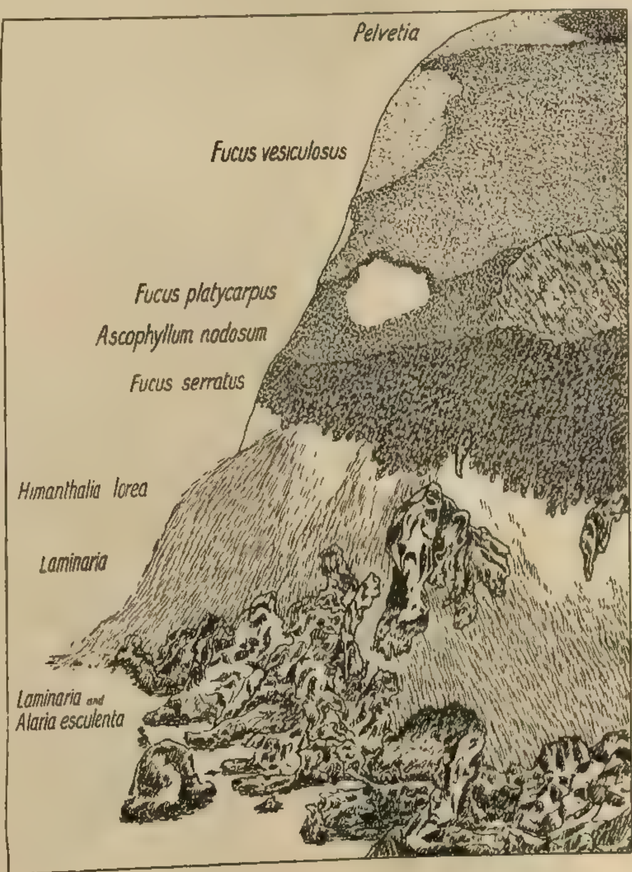
SEAWEED ZONES OF THE TIDE-SWEPT STRAND

MANY people take delight in collecting specimens of the flowers of our countryside, but only a small proportion of amateur botanists think it worth while to turn their attention to the plants of the seashore. Yet the student who enters upon the subject of seaweed classification and makes a collection for himself of the large number of forms scattered about the beach, may be sure of many hours of fascinating employ. Further details of seaweeds are given in a later chapter

EVERY visitor to the seashore is familiar with the appearance of seaweed. The sight of piles of wrack cast up upon the sand and shingle beaches is a common one and makes a part of the pattern of seaside life. High up on the beach lie the hard, dry remnants of weed, marking the uppermost limit of the tide's advance, relics of the storm's fury. On rock reefs and boulder-strewn shores seaweed is found *in situ*, growing in a tangle of stalks and fronds, and forming a shelter for the myriad forms of littoral life.

Most people have noticed that seaweeds are, as a rule, brown in colour, that they are exceedingly slippery to walk upon, and that some varieties pop beneath the feet; further inquiry might elicit the fact that they are found more commonly on rocky than on sandy coasts. This is the extent of the knowledge possessed by the average person who is neither a marine biologist nor an enthusiastic collector of seaweeds, and, though slight, it is quite a sufficient basis upon which to build a full and satisfying understanding of the subject; by the appreciation of a few facts, seaweeds can be raised from being regarded as mere flotsam of the shores to the status of an absorbing and health-giving hobby.

First, it should be realized that all seaweeds belong to the lowly division of plants known as the algae, and that in most of them the normal green colouring of plants, due to the presence of chlorophyll, is obscured by brown pigmentation, or colouring matter. It is possible that this pigmentation is due to the fact that these seaweeds are exposed to a strong light for some hours each day, and that the brown pigment acts as a screen to the chlorophyll.



SEAWEED ZONES—ON THE ROCKS

Seaweeds grow not haphazard, as might at first appear, but in zones, for each appears to flourish best with a particular period of exposure to seawater and to air. The photograph opposite shows clearly how the different zones may be seen on a rock face that is washed by the sea, and the diagram on the right is a key to the seaweeds and the order in which they grow.

There are few places where a perfect succession of seaweeds may be observed, but by learning the zone seaweeds the marine biologist is greatly aided in his work. The photographs illustrating this chapter were taken by Mr. Robert M. Adam, for the most part on the Scottish isles and coasts, but the species represented are generally encountered on our shores.

It is the brown seaweeds which are dealt with in this chapter—first, because they are both the commonest and the most abundant, and, secondly, because they are used by marine biologists for the purpose of dividing the shore into "zones." Before describing these zones further it will be as well to treat a brown seaweed in detail.

ONE of the commonest is *Fucus vesiculosus*, occurring on rocky and boulder-strewn shores in the mid-tide region. It is also known as the bladder-wrack, on account of the air-bladders which support the fronds in the water when the plant is submerged. The seaweed consists of three distinct regions: the disk by which the plant is attached, the stalk, and the frond. The sucking disk is composed of a multitude of cells, and it is by means of this disk that fucus attaches itself to rock; the stalk is shorter than in many of the seaweeds, and the fronds are abundantly forked. Up the centre of each branch of the frond there runs a thickened portion, the midrib. The large air-bladders, which are so noticeable, are paired, and at the surface of the fronds there are a number of dots, the *conceptacles*. Some of the fronds have swollen ends, and on these the conceptacles are much more conspicuous. These large conceptacles enclose the reproductive egg organs and sperm organs. The length of the bladder-wrack may total three feet.

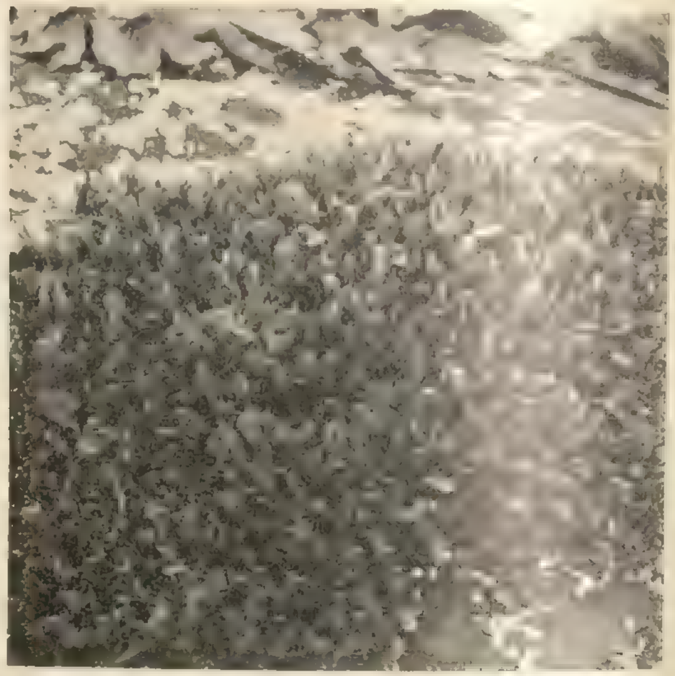
Most of the brown seaweeds used in zoning are related to fucus. First, at the highest level of all, occurs the seaweed known as *Pelvetia*. This grows so high up that for a great portion of its time it is reached only by spray. Thus it is often found in the same zone as a brackish water fauna. Pelvetia is similar to fucus, but is

IN THE UPPER ZONES

Pelvetia (above) is one of the seaweeds that characterize the highest zone; it is never covered by the tide, but obtains moisture from the spray that is blown over it. *Fucus vesiculosus* (below) grows high up in the mid-tide region, but has a wide vertical distribution.

smaller and has narrower fronds, which are channelled as an aid to the retention of moisture. Below the pelvetia zone occur the various fucus zones, which divide up the area that lies between normal tides. First, there is *F. vesiculosus*, which has already been described; below this is *F. platycarpus*, a low-growing flattened form; next in succession comes *Ascophyllum nodosum*, a long string seaweed with numerous air-bladders, which also has the name of knotted wrack; last in the order comes *F. serratus*, distinguished by its fronds, which have serrated borders. *F. serratus* is the lowest of this series of seaweeds and is exposed only at low tide.

It should be remembered that not all these forms will be found together, and that *F. vesiculosus*, in particular, has a wide zone distribution and is usually not confined to a narrow strip between pelvetia and ascophyllum.



HALF-WAY UP THE ROCKS

The fucus seaweeds are typical of most of the mid-tide region. This photograph shows *Fucus platycarpus*, which usually grows at a lower level than the highest plants of *F. vesiculosus*. Note the close bunch-like growth of this seaweed and its flat leaf.

Below the fucus seaweeds occurs the zone of *Himanthalia lorea*, a long stringy form, and below this again come the lowest seaweeds, characterized by *Alaria esculenta* and the famous *Laminaria* zone, which marks the lowest limit of the tidal area. Only during exceptional ebb tides are the laminaria exposed to the air, but when these low tides occur the laminaria zone should be examined carefully, since it contains many of the rarest and most interesting of the littoral creatures. The two commonest forms of laminaria are *L. digitata*, in which the fronds are forked so that they resemble the fingers on a hand, and *L. saccharina*, which has a single undivided frond with a crinkled surface. The laminaria are much bigger than the fucus seaweeds, being longer both in the stalk and the frond. Sometimes these seaweeds are attached to a small piece of rock, which is not large enough to anchor a full-grown plant,

AT LOW TIDE

Associated with the mid-tide growths of the fucus seaweeds is *Ascophyllum nodosum* (above), a common seaweed exposed by the ebb tide and often to be seen by holiday-makers. It is of a lighter and greener colour than the fucus weeds and hence may be easily distinguished from them

SELDOM EXPOSED

Laminaria (below) belong to the lowest zone of all and are laid bare only at exceptionally low tides. This photograph shows a bed of the rather local *Laminaria cloustoni*, exposed during a neap tide. Laminaria are, however, often found cast up on beaches when they have been uprooted by a severe storm.

TANGLED FOLIAGE

Fucus serratus (above) grows in the lower part of the mid-tide region. It is easily recognizable by the jagged and serrated appearance of its fronds. It is often the hiding place of crabs and other marine creatures which take refuge beneath it when the tide is out.

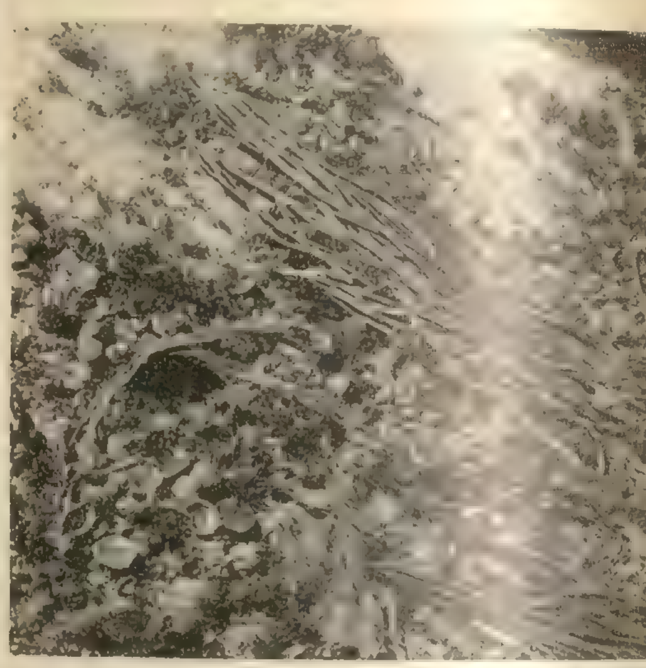
and as the plant grows it is uprooted, rock and all, by wave action and cast up on the shore.

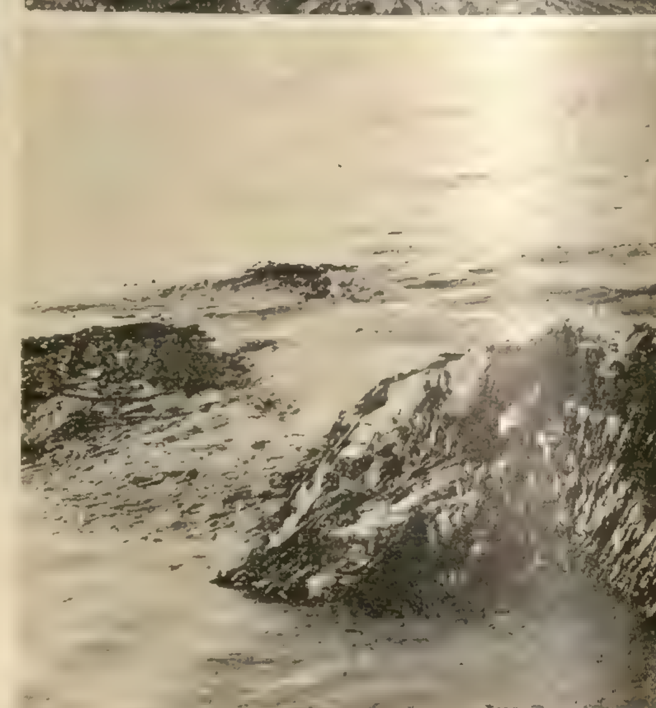
The complete order of zoning, therefore, is:

1. *Pelvetia*	... ...	Moist only at spring tides
2. *Fucus vesiculosus*		Mid-tide zone
3. *Fucus platycarpus*		
4. *Ascophyllum nodosum*		
5. *Himanthalia lorea*		
6. *Alaria esculenta* ...		Low-tide zone: exposed occasionally
7. *Laminaria* ...		

ALTHOUGH the brown seaweeds are used in some countries as a food supply, they are not thus employed in the British Isles. They are, however, of some economic importance in Scotland and Ireland, where the wrack, or kelp as it is called, is collected in carts, heaped in large piles and burnt. The ash is then used to dress the land, serving the double purpose of retaining moisture and manuring the soil.

The zoning of seaweeds in this fashion serves the useful purpose of dividing up the shore line into a number of horizontal sectors, so that the marine biologist may, without difficulty, refer any specimens that he collects to any one portion of the shore. The zoning is never quite exact, since some of the seaweeds may overlap their boundaries, and many of them may be absent from a particular portion; but as a rough and ready guide the seaweed zoning is effective, and one that may be used by the casual holiday-maker as well as by the experienced biologist.





IN THE LOWEST ZONES

Himanthalia lorea (upper photograph) is found at the bottom of the mid-tide region, while *Alaria esculenta* (lower photograph) occurs even lower down, being associated with *Laminaria* and thus being exposed only at very low tides. These low zones are always the most interesting hunting grounds for the marine zoologist.

HARMLESS SNAKES OF HEATH AND FIELD

THE viper or adder, Britain's only poisonous snake, is described in the ninth chapter of this series devoted to our wild fauna (see page 311). Now we have a description of the other two snakes that may be encountered in a wild state, the grass snake and the smooth snake. Though they are very much alike, there are certain features by which they may be differentiated, and these are fully set forth in the text

OF the three British snakes, the adder, the grass snake and the smooth snake, only the first, described in pages 311–314, is venomous; the others are quite harmless. The grass snake (*Tropidonotus natrix*) is the largest of our reptiles; when fully-grown the female may sometimes reach as much as four and a half feet in length, and the males are usually about a foot shorter than the females. Exceptional examples have been recorded in some parts of the country, especially in the New Forest, where a few years ago a specimen was killed which measured over six feet.

Although somewhat similar to the grass snake, the smooth snake (*Coronella austriaca*) has a number of marks of distinction by which it may be recognized. The smoothness from which it gets its name is perhaps the most obvious feature, but it is also far shorter than the grass snake, having a maximum length of about two feet. The scales on the grass snake are not flat, but ridged into tiny keels, while those of the smooth species are without any ridging, thus producing a "smooth" effect when the snake is allowed to glide through the hand. As regards the number of rows of scales on the back and sides of the two harmless snakes, it may be mentioned that there are always nineteen in both species, while in the adder there are from twenty-one to twenty-three. Each of the scales in the smooth snake is connected with a nerve fibre and has on the outside a tiny pit which coincides exactly with the end of the fibre. From this it would appear that each scale in this species is capable of sensing touch, so that the whole of the snake's body is sensitive to its surroundings.

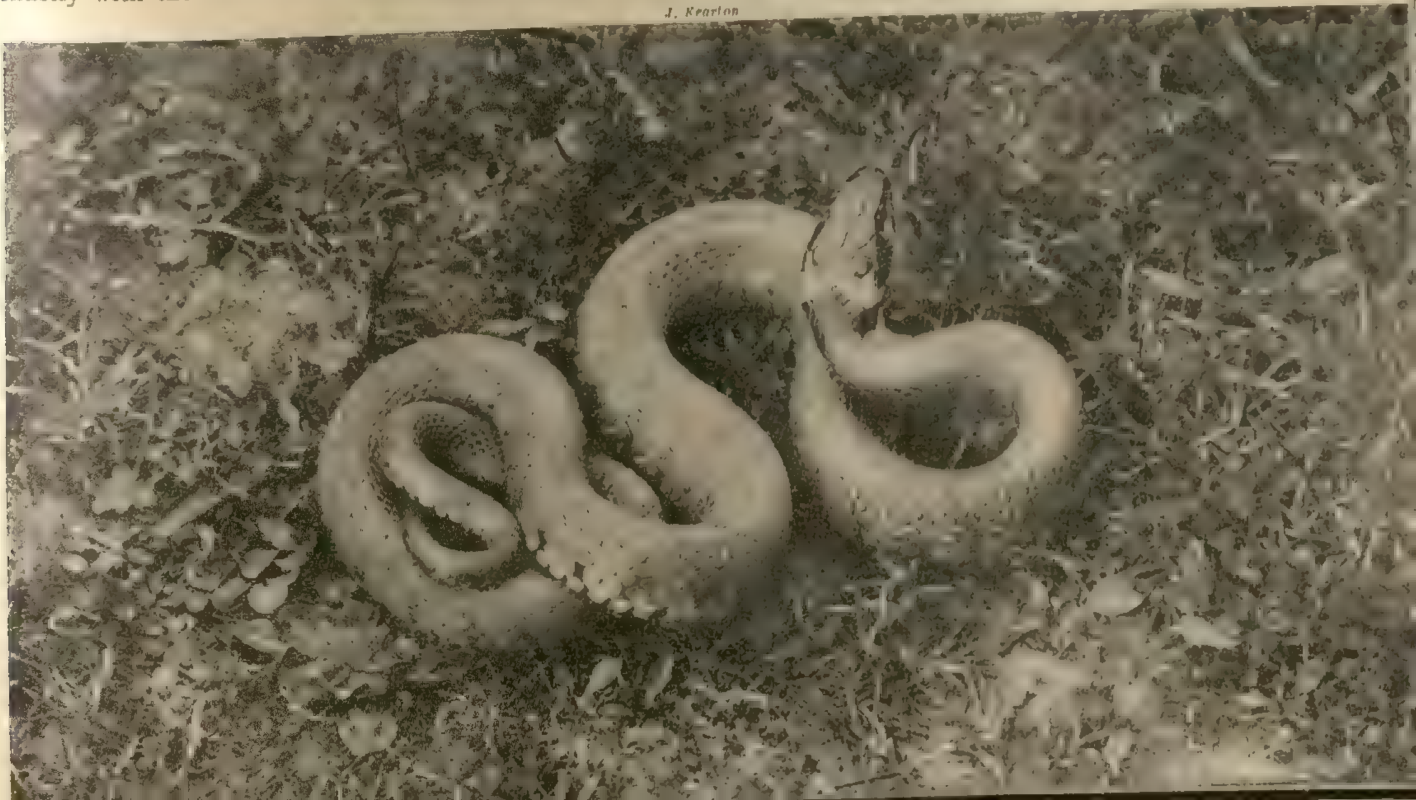
In shape the grass snake is very graceful, for the body tapers gently from about the middle of its length to the tip of the slender tail. As a whole its form is a better example of natural "streamlining" than that of either the adder or the smooth snake. The long head is covered with large shields, and ends in an unexpectedly blunt snout, with the eyes and nostrils situated at the sides. The large eyes have round pupils which are surrounded by the band of gold and dark brown of the iris, and when we remember that the adder has a vertical pupil—a sign usually of nocturnal habits—we have yet another well-marked characteristic by which the harmless snake (for the smooth snake, like the grass snake, has a round pupil) may be readily distinguished from its venomous cousin.

IN coloration the grass snake is fairly characteristic, for just behind the head there are two patches of yellow and orange which form a brightly-coloured collar, absent only in very large females. Behind this collar there are two black patches, sometimes joined at the top to give

KNOWN BY ITS COLLAR

The grass snake is the longest of the three snakes found in Britain, fully-grown females sometimes extending to over four feet. A characteristic feature by which it may generally be identified is the pair of yellowish-orange patches on its neck, and from this collar it derives its second name of ringed snake.

J. Kearton



W. S. Berridge

SMOOTH TO THE TOUCH

The smooth snake is so called because of the smoothness of its skin, due to the absence of any keels or ridges on the scales. Considerably smaller than the grass snake, it is covered with pairs of black, brown or red spots, whereas the grass snake has along each side one line of dark brown bars, clearly rendered in the photograph in page 227.

a saddle-like appearance. The ground colour of the rest of the body is grey, olive or brown, according to locality and natural variation, but it is practically always uniform with the colouring of the tail. On the back of the body there are two rows of small dark brown spots, and on each side a row of vertical bars of a similar shade. The under-surface is covered with very broad plates and is either chequered black and white, or is entirely grey or completely black.

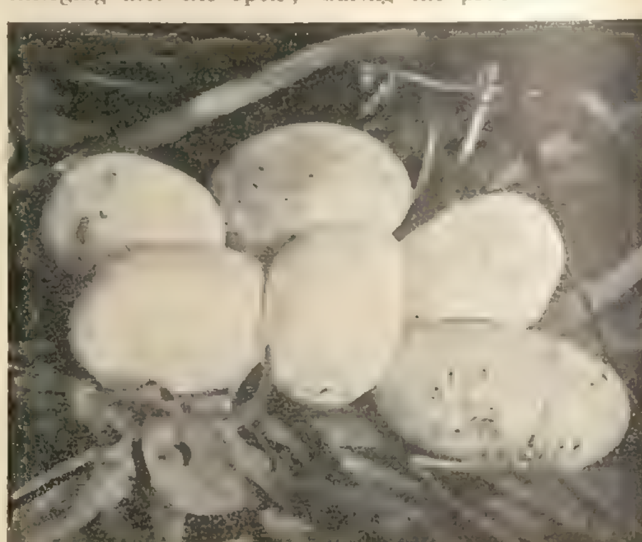
Colour and Markings of the Smooth Snake

As regards the smooth snake its coloration is usually grey on the upper side, but brown and red specimens have been observed. It is covered with a number of small black, brown or red spots nearly always arranged in pairs, though in some varieties these appear as three longitudinal stripes in a lighter hue. The top of the head is black in the young, but with maturity the colour usually fades to the same tone as the rest of the body. From the nostrils to the eyes there runs a dark streak, which is continued down from the eyes to the angle of the mouth; sometimes this streak is extended even farther, running the entire length of the body as far as the tail. The under-surface is nearly always some tint of orange, red or brown, but, as with all snake markings, no definite statement can be made, for many naturalists claim to have obtained specimens both grey and black on the underside, and in some reported cases spots have been observed.

Naturally enough, like all animals, the grass snake is usually encountered in those districts where its principal forms of food may be found. Living mostly on frogs, toads and newts, it loves the lush grass of meadowlands, but it is by no means restricted to such resorts, and may be discovered on very dry chalky hills, sandy heaths, and in other districts where there is no water at all. In such habitats it feeds on mice, small birds and, occasionally, worms and slugs. When near a stream or pond a grass snake, like the adder, will often enter the water to swim after its prey, the swimming action being a horizontal, side-to-side movement —not vertical, as is so often supposed. When captured, disturbed or frightened in any way, both the grass snake and the smooth snake eject as a protective device a secretion with a pungent odour likened to that of garlic.

In the autumn the grass snake retires into a hiding place for hibernation, and during the winter sleeping specimens may often be discovered under piles of brushwood, beneath the roots of fallen trees or in other sheltered spots. Usually a number of snakes hibernate together, twisting themselves into complicated knots. They remain in a state of hibernation until the spring (March or April), when, as soon as the frogs and toads are about, the snakes come out to prey on them.

The smooth snake hibernates in much the same places as the grass snake, and both species pair soon after emerging into the open; during the process the male



M. H. Crawford

GRASS SNAKE EGGS

The eggs of the grass snake usually number sixteen to twenty and have "shells" of a tough, parchment-like substance joined together in a string. Immediately after being laid they absorb moisture from the air and begin to swell until they are about an inch and a half in length. The hatching process is illustrated in page 225.

snake seizes the female in his jaws and entwines her with his body. About July or August the females of both species seek for suitable quarters in which to deposit their young, but whereas the grass snake lays a whole string of a dozen or so oval and tough, parchment-like eggs, the female smooth snake retains her eggs within her until the young are ready to hatch out. The young of the smooth snake number from a couple to as many as fifteen, and are about four to six inches in length.


G Hearn

CAST-OFF GARMENT

Here we see the cast skin of a grass snake, turned inside out during the process of sloughing. Just as a crab sheds its shell to permit growth, so batrachians and reptiles cast their skins at regular intervals for the same reason.

As soon as the eggs of the grass snake have been laid, they start absorbing moisture from their surroundings and begin to swell. This process goes on for a few weeks, when they reach a size of about an inch and a half in length. They hatch out after some six to eight weeks (*see* the photograph in page 225), the young grass snakes being approximately seven inches long, somewhat larger than the baby smooth snakes. Before hatching, the embryo grass snake is provided with a special egg-tooth projecting in front of the jaws, by means of which it pierces the shell of the egg; this tooth soon becomes loose after its single function has been performed, and drops out within a few days. The young snakes—grass and smooth—shed their skins before taking their first meal, and this process is repeated about four times a year throughout life.

The food of the smooth snake is somewhat different from that of the grass snake, for this reptile spends its time, not in the rich grass of the meadowland, but on heaths and wooded hillsides. Here it subsists upon lizards, including slow worms, and young snakes, and sometimes it eats mice, voles and baby birds. Some naturalists state that when the mammals attacked by the smooth snake are sufficiently large, the reptile coils itself round them after the manner of the boa-constrictor.

The smooth snake is restricted to the south of England; specimens have been discovered in the New Forest and other parts of Hampshire, as well as in Dorset, Surrey and Berkshire.

The grass snake is a native of all parts of England and Wales, and is also found in the south-east of Scotland; there are no snakes in Ireland.

SNAKE *v.* FROG

Grass snakes find frogs attractive, if difficult, mouthfuls. Here we see (left) a snake unsuccessfully attempting to swallow a large frog and (below) a smaller victim being swallowed alive and whole.

A. R. Thompson

RARER COUSIN OF THE COMMON ELM

As its name suggests, the wych elm is a close relative of the common elm, described and pictured in the fifth chapter of this series (page 144). Like its cousin though it be in many respects, it is, however, sufficiently dissimilar to be readily distinguished, and the various points of difference are clearly stated in the study of the tree which appears below

It is a curious fact that many of our truly indigenous trees are less common and less popular than other, closely related species which are not actually natives of the British Isles. An example of this is provided by the two elms: the common elm, which is described in pages 144–146, and the wych elm. The former is by far the better-known tree, and yet, although it has certainly grown in this country since Roman times, it is considered to be an introduced species, whereas there is no doubt at all that the less well-known wych elm is a true native. The latter tree is also known as the Scotch elm and the mountain elm. The first of these names is justifiable, for this tree is far more common in the north of England and in Scotland than is its cousin. But the name mountain elm, on the other hand, seems to be without foundation, since, in England at least, it is the common elm that is found at great heights, although on the Continent the wych elm is found at a height of over 3,000 feet above sea-level.

The name " wych " is one of those ancient terms that have provided a puzzle for etymologists for centuries. Some say that the word comes from an Anglo-Saxon name of a tree, while others, having in mind that " wych " is often spelt "witch," assert that there was some connexion between the wych elm and witches. A further source of confusion is the fact that the wych elm is alternatively called the witch hazel, whereas in America the witch hazel, the source of witch-hazel ointment, is a totally different tree or shrub.

" Small-leaved elm " is one of the alternative names of the common elm, and this suggests a reliable means of distinguishing between the two species. The leaves of the wych elm often grow to a great size, and, not being divided or cut up in any way, are always larger than those of the common elm; they average three to six inches in length. Their general shape is ovate, but they are asymmetrical, being larger on one side of the midrib than on the other, and they are longer in proportion to their width than are those of the common elm. The edges are coarsely serrated, and the surface rough and covered with stiff hairs. On the underside of a wych elm leaf there will be found a number of specially large hairs, particularly along the ribs, and these serve to guard the pores from dust and dirt. The efficient manner in which they fulfil their task is shown by the fact that the leaves of wych elms growing in city parks are often found to be covered with particles of soot which have adhered to these hairs and in this way have been prevented from entering the pores.

The wych elm cannot readily be distinguished from the common elm by its flowers, but the fruits differ in several important points. The wings of the wych elm fruit, which is of the type known as a samara, are squarer than in the common elm, and the seed itself is near the centre instead of towards the upper end of the samara. Both the flowers and the fruits of the wych elm are slightly larger than those of the common elm, the difference being sometimes as much as one third. The flowers themselves are about a quarter of an inch in length, consisting of four or five petals or sepals and as many stamens; in colour they are brownish, sometimes rather

WYCH ELM PAIR

This magnificent pair of wych elms have the typical form that contrasts strongly with that of the common elm. As will be seen, they have a number of equal trunks running up together, instead of the common elm's single trunk branching out into an umbrella-like head at its summit.

A. W. Dennis

A. W. Dennis

SUMMER'S LEAFY LOAD

In the fullness of their summer beauty, these two wych elms spread their shade over a wide area. In summer as in winter (compare the photograph on the opposite page) the great heads of branches, like half-folded fans, differ widely from the form adopted by the common elm as seen, e.g. in page 147.

paler than those of the common elm, and they share with the flowers of that tree the habit of appearing as early as March, long before the leaves are out. For this reason the elms, like certain other of our trees, wear a pleasant purplish bloom before the green, which betokens the coming of spring, has appeared.

Although the average height of the wych elm is less than that of the common elm, large trees of this species are said to reach a hundred and twenty feet. When this is the case, the girth may be as much as fifty feet, although such a size is exceptional. The rough, irregular bark is often corky in texture, and the twigs may be covered with curious, corky wings. It is often said that the wych elm does not send forth those suckers round the base which are so typical a feature of the common elm, but although this may be true in many cases, it is certainly not a hard and fast rule. One feature of note is that the wych elm will grow much more easily from cuttings than will its cousin, and it can also be propagated by layering, that is, by pegging down shoots into the ground. When they have taken root, they are detached from the parent tree, and grow as new, individual trees.

E. J. Hosking

INCIPIENT SAMARAS

Here we see the female flowers of the wych elm after the males have died and left behind them the fertilized ovaries. The two-cleft stigmas can be seen, and the bunches of enlarging ovaries will soon be samaras such as are pictured overleaf.

A variety of the wych elm that is often grown in gardens and urban parks is the weeping wych elm, in which the branches bend downwards and hang gracefully round the main trunk, in the same manner as those of "weeping" ash trees. In general, the wych elm is a wider-spreading tree than the common elm, its outline being less umbrella-shaped. This is due to the fact that there is very often no single main trunk, but a number of small branches which grow to about equal stature. As timber this tree is not so valuable as its cousin, on account of its much quicker growth.

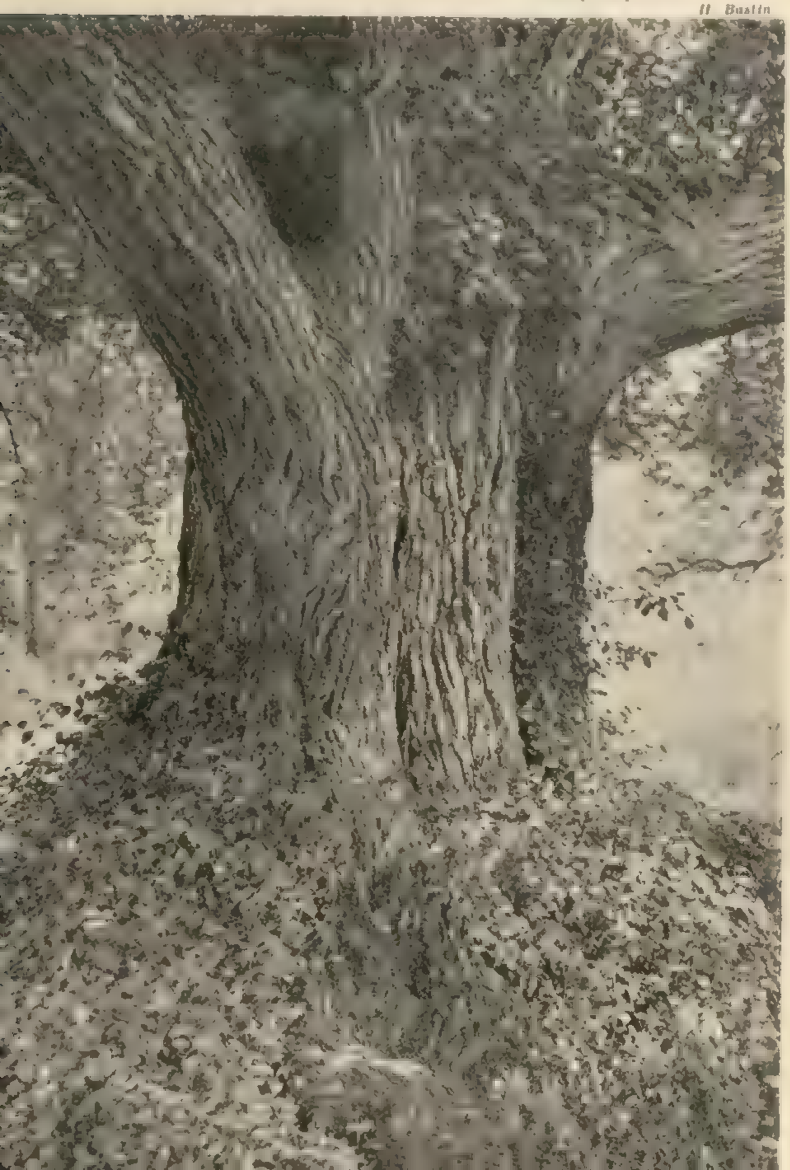
Testing for Dutch Elm Disease

LIKE the common elm (*see* p. 146), the wych elm is subject to the attacks of the elm bark beetles, which often, through their own efforts and indirectly through those of the other agents that they introduce, eventually kill the trees. Since there is often doubt, when an elm is seen to be dying, whether its approaching demise is due to the "Dutch elm disease" or not, it may be as well to give some indication as to how the naturalist or arboriculturist can make sure. The one infallible test is to cut off and examine a twig whose leaves are seen to be dying. If the centre is brown—the sign of fungal agents at work—the tree has the disease; if it is not brown or otherwise discoloured, then we must look elsewhere for a reason for the tree's sickness.

MIGHTY GIRTH

Generally the wych elm does not exceed in height its common cousin, though as a rule its girth is considerably greater. The specimen seen in this photograph is a very fine one, but examples have been recorded with girths of nearly fifty feet.

H. Bastin



FRUIT AND LEAF

The fruits of the wych elm (left, in the above photograph) are larger than those of the common elm (right, above), and have the seeds near the centre, whereas in the latter the seeds are towards the upper end of the samara. Inset is a typical wych elm leaf; note the characteristic ear on one side of the base.

Although in the present chapter, as well as in that dealing with the common elm, the differences between the two species have been pointed out, it may be convenient to have them clearly stated in tabular form:

	Common Elm	Wych Elm
Trunk	Single, straight, umbrella top	Usually several trunks after a dozen feet, spreading shape
Leaves	2 to 3 ins., serrated	3 to 6 ins., larger serrations, eared at one side of base
Flowers	Bunches under ⅛-in. dark brown	Bunches ⅛-in. paler brown
Fruits	Seeds near outer edge of samara. Seeds ripen only occasionally	Seeds near centre of samara. Seeds ripen annually
Bark	Rough and hard, deeply fissured	Often corky, less deeply fissured

In addition to these points, it may be noted that the wych elm has a greater girth, but does not grow to such a height as the common elm, and that it does not often have suckers growing round the base.

FROG-HOPPERS & THEIR CUCKOO-SPIT NURSERIES

ONE of the most puzzling of the natural phenomena that meet the rambler's eye, the cuckoo-spit (as is explained below) has nothing to do with cuckoos, but is the work of a little insect called the frog-hopper. The why and the how of the frothy masses are fully explained in this chapter, and mention is made of some of the frog-hopper's relatives

A RAMBLER'S first contact with cuckoo-spit will be, as likely as not, when he has picked a flower growing in the hedgerow or by the wayside, and finds his fingers wetted with the frothy, soapy mass of bubbles that is clinging to the stem. As often happens with objects whose names are dictated more by tradition than by scientific truth or accuracy, cuckoo-spit has nothing to do with either part of its popular name. It is, in fact, the creation of an insect known as a frog-hopper, a member of a group that we have so far not described in this series.

Frog-hoppers are notable representatives of the great group of *Hemiptera*, or bugs, one of the most important of all the orders of insects, especially from the economic standpoint, for members of this group are among the most harmful of all living creatures. This order is divided into two sub-orders, known as *Heteroptera* (that is, insects having wings of different kinds) and *Homoptera* (insects having wings of the same kind). In the Heteroptera the basal half of the fore pair of wings is chitinized, or made horny, while the terminal part is transparent. These wings are used as protective covers for the hind wings, much in the same way as is seen in the beetles. In the Homoptera, on the other hand, the whole of the fore-wing is of the same structure, either horny or transparent.

Heteroptera and Homoptera Compared

HETEROPTERA comprise the plant-bugs proper, which are divided into a number of families. These insects are described in a later chapter, but a few further points that distinguish them from the Homoptera may be mentioned here for the sake of convenience. There is a very noticeable triangular patch between the bases of the two fore-wings, similar to that found in the beetles, and, as with the beetles, known as the *scutellum* (Lat., little shield). The wings are folded flat over the back, their apices coming one on top of the other, whereas in the Homoptera they are at an angle with the axis of the body, forming a marked roof-like ridge all down the back. In all the bugs there is no true metamorphosis, that is, there is no regular change from egg to caterpillar, thence to pupa, and thence to adult. From the moment the little hemipteron hatches from its egg, it is in almost all respects a tiny replica of its parents. In most cases the immature insect cannot fly, and it may live in a different situation from its adult form, but there is no sharply divided series of stages.

The frog-hopper, the subject of the present chapter, is a member of the sub-order Homoptera, within which it is classed in the family *Cercopidae*. The frog-hopper earns the first part of its name from the appearance of the head, which is rather flattened and broad, so that it certainly does seem to resemble that of a miniature frog. The second part of the name refers to the remarkable hopping powers of the adult insects. They make their hops by taking off with the aid of the powerful hind legs, which are equipped with a number of strong spines, and, once in the air, they open their wings and parachute for some distance. The wings are also used for flying after the insect has launched itself into the air. The adults are moderately hard and tough-bodied, but in the immature stages these insects are very soft and weak, and it is doubtless to aid them in protecting themselves

FROTHY ATTACHMENTS

This dock plant provides a home for a colony of several cuckoo-spit insects, whose soap-like exudations are seen clinging to the stems and leaves. In the middle of the top mass of froth can be discerned the pale form of the insect responsible, the nymph of the frog-hopper, a homopterous bug.

L. J. Langford

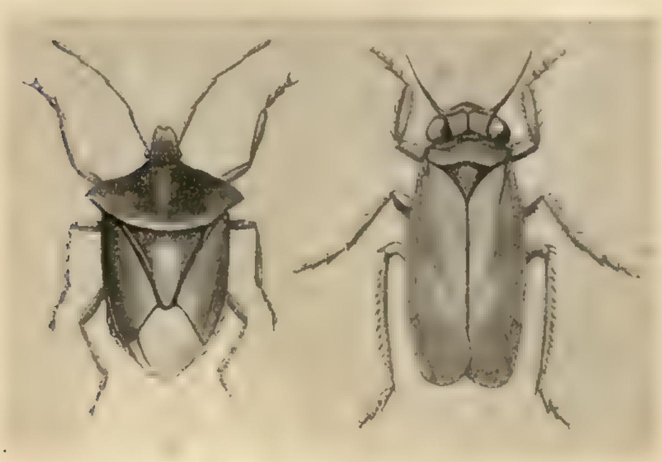
J. J. Ward

RESTING PLANT-BUGS

The insects seen clinging to these birch fruits are shield-bugs or plant-bugs. Typical of the sub-order *Heteroptera*, they are described in detail in a later page, but are illustrated here for the purpose of comparison with the hoppers, representative of the other sub-order of the *Hemiptera*, the *Homoptera* (× 1½).

against their numerous foes that they have recourse to the mass of cuckoo-spit in which they live.

As to how the insect starts its life there is a good deal of doubt, for no one seems to have found out exactly where the eggs are laid. It is probable, however, that they are deposited, with the aid of the sharp, fine ovipositor, or egg-laying organ, in the tissues of the plant on which the young will feed, probably near the base of the stem. Egg-laying takes place in the autumn, and after performing this duty the female insects die. Early in the following spring the tiny nymphs, as the immature hoppers are called, hatch out, and at once crawl up the stem and begin to feed. A characteristic of the bugs is that they are armed with mouth-parts that are very specially adapted to sucking plant and animal juices, and the little frog-hopper is no exception to this rule.



KNOWN BY THEIR WINGS

These diagrammatic drawings show the differences between the members of the sub-orders *Heteroptera* (left) and *Homoptera* (right). In the latter the wings are all of similar construction, while in the former they consist of a chitinous upper part and a small, transparent part that folds over the equivalent area on the other wing.

Seemingly the mass of cuckoo-spit is formed in the following manner. When the insect sucks the juices of the plant there is a large amount of waste matter which it is unable to digest and which is excreted. This excreted matter combines with a secretion from certain glands in the abdomen of the nymph to form a sort of sugary sap, which ferments rapidly on coming into contact with the fresh air. When a largish drop of this fermenting liquid has collected around the tail of the hopper, the insect, by moving its rear extremity to and fro, introduces a certain amount of air into the drop, thus gradually whipping it into a frothy mass. One point to note is that the frog-hopper's bubbles last much longer than any made by human agency.

The name "cuckoo-spit" itself seems to have arisen from a rustic idea that the little frothy masses were actually the spittle of the cuckoo, for they first appear about the time that the cuckoo reaches our shores, and they last approximately throughout the cuckoo season.

Not only does the cuckoo-spit act as a protective covering for the insect, by concealing it from its enemies, but it is also of great value in preventing the frail, soft

H. Bastin

'HOPPERS' COMPARED

Two common species of hopper are here seen, those on the left being the large hopper, brilliant black with red spots, while the right-hand picture shows the sombre brown and buff frog-hopper which is responsible for the cuckoo-spit. Both are typical members of the sub-order *Homoptera* (× 2).

body of the nymph from being dried up by the heat of the summer sun. The larva feeds head downwards, so that the bubbles cover it from the tail onwards, although the head is never exposed for long. The insect does not remain in the same spot for its whole life, but moves about over the stems of the plant which it is attacking. From time to time it moults, the old shed skins being sometimes visible round the outside of the bubbles. Eventually, some time during the summer, the nymph sheds its final skin and is then ready to emerge for ever from its frothy home into a world of bright sunlight, where its sole purpose is to find a mate and assist in the perpetuation of its race.

Not all the members of the frog-hopper group make these frothy masses in which to live. The common cuckoo-spit insect is, however, also the commonest of the group, and it goes by the scientific name of *Philaenus*







'CUCKOO-SPIT' STORY

This series of photographs depicts the life of the cuckoo-spit insect from the time when it enters its mass of froth until its final re-appearance as an adult "hopper." The first photograph depicts an immature hopper that is outside its "bubble," and shows the rounded, indeterminate contours and soft, unprotected body that is characteristic of the animal at this stage. The following five photographs show the way in which the insect produces an ever larger bubble as it grows up. Two specimens can be seen, one at the top right-hand corner of each picture, the other towards the bottom of the stem. Above the lower mass of froth can be seen a moulted skin. In the fifth picture the upper insect has changed its position, and in the sixth the full-grown insect has just emerged from its frothy home. In the two bottom pictures the insect is seen in characteristic attitudes on stems of plants. All these pictures are rather more than life-size.

Photos, J. J. Ward

J. J. Ward

FROG-HOPPER DISPLAYED

Looked at through the microscope, the frog-hopper seems very different from the neat little creature photographed in the previous page. The eyes are seen as two white patches, one on either fore-corner of the head, and the details of wings and legs are well marked, the veining of the hind wings being specially clear (× 10).

spumarius. It is a brownish creature in the adult stages, about a third of an inch long or rather less. Another form which is very common in certain localities, though not found everywhere, is *Cercopis sanguinolenta.* One of the most striking of all our insects, it is about half an inch in length, often less, and is a very fine deep blue-black in colour, having on the fore-wings a number of brilliant scarlet patches. It is an erratic insect, appearing in some years in great numbers, so that one can hardly avoid seeing it, but it may be almost completely absent for years at a time. A very energetic hopper and often a difficult insect to catch, it is found chiefly in the long herbage on the edges of woods and copses.

A third form of frog-hopper is that known as *Aphrophora alni,* the alder hopper, which is very similar to the common frog-hopper, but considerably larger. There are many smaller species found in the British Isles, and one of the prettiest is a little greenish-blue species that is very common in rushes and herbage round the edges of damp woods.

Besides the cockoo-spit insects, there are a number of other common homopterans to be found even on the shortest ramble. These include such forms as the aphides, the green- or black-fly of the gardens, and their many relatives that live on wild plants and trees. There

H. S. Cheavin

HOPPER DETAILS

This moth-like object is the large hopper, *Cercopis sanguinolenta,* seen when set out on a slide under the microscope. The eyes, wings and abdominal segments may be examined conveniently, and the tiny antennae may be just discerned in front of the head. The middle legs can be seen beneath the wings (× 7).

is also a rare insect known as *Cicadetta montana,* confined to the New Forest, which is our only representative of the family to which belong the famous cicadas of southern Europe and the tropics. The aphides are described in a later chapter in this series.

Revealers of Nature. 15

REV. J. G. WOOD

THE figure of a black-coated clergyman standing beside a blackboard and easel and sketching swiftly a portion of animal anatomy was a familiar sight in the church halls and municipal meeting places of Great Britain and America in the 'eighties of the last century; indeed, the zoological "sketch-lectures" of the Rev. John George Wood were a medium of instruction and entertainment that was extraordinarily popular in those pre-cinema days. With his chalks and blackboard Wood travelled vast distances in this country and in the U.S.A., attaining a reputation among the more serious-minded lecture-goers that was truly remarkable. His lectures were the great forerunners of the instructional Nature films with spoken commentary, made by Miss Mary Field and others at the beginning of the talking-film era, and, considering the difficulties that a low standard of general education put in his way, he deserves to be reckoned a pioneer in a new form of Nature-revelation. But apart from his lectures, which, in all probability, not many living persons can recall, Wood is still famous today as the author of a vast number of ever popular scientific books.

Eschewing all technical language (of which, indeed, he was in no sense a master) and all the less attractive aspects of Natural History, such as classification and systematization, he presented perhaps for the first time practically the whole field of Natural History to the man in the street. For over thirty years a constant stream of these

popular works poured from his pen; the most important are "The Illustrated Natural History" (the first of them), "The Natural History of Man," "Insects at Home," and "The Zoo." But there are literally dozens of others—"Animal Traits," "Bees: their Habits and Management," "Common Objects of the Seashore," "Common Objects of the Microscope," "Our Garden Friends and Foes," "The Fresh and Salt Water Aquarium," "English Scenery Illustrated," "Birds and Beasts," "The Brook and its Banks," "The Dominion of Man," and so on. Indeed, there is scarcely any branch of Natural History that Wood left unpopularized.

Many of his books are, of course, written for children, and Wood was for some time editor of "The Boy's Own Magazine." But these activities represent only a tithe of his many interests: he also published many books on "manly sports" and "healthy pastimes," and on Biblical history, and from 1852 until 1875 was active in his original profession—that of the Church. Born in July, 1827, he was educated at Oxford, was ordained in 1852, and was at various times chaplain to St. Bartholomew's Hospital, reader at Christ Church, Newgate Street, and precentor of the Canterbury Diocesan Choral Union—a position in which his influence on church music was considerable. He began his lectures as early as 1856, and from 1879 devoted his life to them. He died while on a lecturing tour on March 3, 1889.

If there are few who can remember Wood's blackboard, there must be many who have found his little books an inspiration and a joy. Many famous naturalists have traced their original interest in Natural History to a chance encounter with one of Wood's works, and it might almost be said that he, more than anyone, made the public aware of the subject's existence. And it says much for his breadth of mind that, in spite of his deep religious convictions and position in the Church, and at a time when such belief was regarded almost as heresy, he accepted many of Darwin's conclusions concerning the evolution of Man.

BUNTING SONGSTERS OF THE HEDGEROWS

BUNTINGS are members of the finch family, and one of their number, the reed bunting, has been described in an earlier chapter (page 366). Now we proceed to make the acquaintance of the yellow bunting or yellow-hammer, the corn or common bunting, and the cirl bunting, and also of the still more finch-like linnet and redpolls. All are, as might be expected, of very similar appearance and habit, but each is well worthy of study as an individual

SOME birds attract our attention by the music of their song; others, it may be, by the time of year or time of day at which they sing; others, again, by the insistence of a song that is not in itself particularly musical or beautiful. The yellow-hammer belongs to the last class, along with several of the other members of the finch tribe, such as the chaffinch, which is described in page 329. That the yellow-hammer should be famous for its song at all is contrary to our expectation, for its musical quality is negligible. But the reason for its familiarity is to be found in the facts that the bird sings over a very long period of the year; sings in places where there are often very few other birds; and possesses a song that can be more easily "put into words" than that of any other bird. Two or three preliminary notes, usually transcribed as *chit, chit,* are followed by a little phrase that is traditionally rendered as "A-little-bit-o'-bread-and-no-cheese," the last word being drawn out in a manner reminiscent of the single note of the greenfinch. The widespread distribution and popularity of the yellow-hammer are attested by the fact that Scotland has a separate version of the song, namely, "De'il, de'il, de'il, tak ye." This delightful little song may be heard from early February until the autumn, and the bird sings from dawn till dusk throughout that season.

E. J. Hosking

FORAGING FATHER

This handsome cock yellow-hammer is seen searching for provender for his healthy and hungry family. Sitting on the ground in a pose characteristic of his tribe, he displays for all to see the yellow patches of his head and the boldly streaked feathers of back, mantle, and wings.

ONCE having heard the song, which can easily be recognized if the above phrase is borne in mind, the rambler should have little trouble in locating the songster, for, unlike the warblers described in page 453, which chirrup incidentally during voyages among the deep undergrowth of the hedgesides, the yellow-hammer sings from a perch. A post, the top of a bush, a telegraph wire, fence or any other elevated site serves as a platform for this energetic singer, and serves also to show off the fine plumage which has earned for him his name of yellow-hammer or yellow bunting. The colouring varies considerably according to the time of year, but is at its best during the breeding season. Head, throat and underparts generally are clear, brilliant yellow, streaked, in the case of the head and throat, with brown. In contrast to this, the back, mantle and, especially, the rump are chestnut-coloured, all except the rump being also streaked with brown. The hen bird is browner, with little or no pure yellow, and more streaks of duller brown; but she bears a distinct stripe like a thin, black moustache. As in the case of the chaffinch, the fine colours of the male bird become muddied and obscured after the autumnal moult, but by the spring the plumage is as fine as ever. The quality of the yellow varies greatly in individual birds.

Essentially a bird of the hedges, the yellow-hammer builds its nest low down, often actually on the ground; the rising bank that supports the hedge is a favourite site, and on common lands the lower parts of a thick

DEEP IN THE BUSH

The yellow-hammer's nest is usually well-hidden in the depths of a bush, and this example, surrounded with brambles and bracken, is no exception. It is a neat structure, though not so neat as that of some other avian builders, and is largely composed of fine grasses.

R. Gaze

C. W. Teager

GAPING BEAKS

Tremendous enthusiasm greets this yellow-hammer on its return to the nest, the babies raising high their heads in their anxiety. The white marks on the insides of their mouths are said to act as guides for the parents when feeding the young.

gorse or bramble bush are often favoured. Grass, moss and perhaps roots go to the construction of the nest, which is lined with hair. The eggs, three to five in number, are dirty white, covered, especially round the larger end, with curious markings which have earned for the bird the additional names of "writing lark" and "scribbling lark." By the more superstitious country people this is considered to be actual writing and is interpreted to mean "Don't take my eggs." The first brood is laid in April, and there are usually two broods, so that eggs may be found in the nest quite late in the summer. Eggs found as late as October have been recorded; these were probably a third brood.

Ways of the Yellow-hammer

THE yellow-hammer exhibits one of those wonderful instances of parental ingenuity that we occasionally find in birds, for, when surprised at the nest, the hen bird will often fall out and tumble about on the ground near by in an attempt to draw the marauder's attention away from her young. In winter yellow-hammers are most sociable birds, joining with their fellows, and with parties of other finches, to raid the rickyard in search of seeds. But in spite of their typical seed-eater's beak, which they have in common with the other finches, they are insect-eaters during the summer months, and as such are amongst the most welcome birds on a farm; although they eat a few seeds, the damage they do is more than outweighed by the value of their work in keeping down noxious insects, and many of the seeds, too, are those of weeds that any farmer would be glad to be without.

A near cousin of the yellow-hammer, but one that is not by any means so well known, is the corn bunting—sometimes also known as the common bunting, although it is certainly not to be regarded as common in the usual sense of the word. Found only in certain districts, although there it is quite abundant, it is made inconspicuous by its dull plumage and quiet habits. Certainly the dowdiest member of its group so far as plumage is concerned, it is also the largest, measuring seven inches from beak to tail, and its build is very heavy and solid.

Dreary Song of the Corn Bunting

NEITHER is the bird's general character attractive, for it seems to be content merely to sit on top of a hedge or, for choice, a wire fence, monotonously reiterating its dreary little song, best described as "the sound of a bunch of small keys being jangled together." Lord Grey himself was roused by this bird's habits to remark that it was probably glad when barbed wire was invented, such an attachment does it seem to have for fences composed of that obnoxious material!

It is, in fact, hard to find anyone who will say a good word for the corn bunting; but let not this fact excite our sympathy, for the bird does little, if anything, to redeem itself in the eyes of farmer or naturalist. The former is inclined to treat it with anything but respect, for it is even more of a seed-eater than most of the members of its group, and it prefers rather bare, well-cultivated land to any other situation; while the naturalist intent on making an inspection of the eggs will find the

A. H. Willford

SCRIBBLED EGGS

The markings on these yellow-hammer's eggs are typical of the bunting group, and differ from those found on the eggs of any other type. Curiously like some ancient hieroglyphics, such markings have earned for the buntings the name of "scribbling larks."

corn bunting an annoying bird, for, although the male bird by his persistent "singing" betrays the presence of a nest, this is exceedingly difficult to locate, being usually lodged in low herbage or on the bare earth in the centre of a cultivated field. In the construction of the nest, again, the bird displays a carelessness unusual in a family which affords such examples of neatness as the nests of chaffinch and goldfinch, and the bunting's is often a most untidy structure, composed of grass, straw and moss, and lined with hair. The four to six eggs are laid late in the season, often not till June, and are of the same type as those of the yellow-hammer, though larger and with a more reddish or purplish background. Besides the scribbled markings there are usually a number of reddish-purple blotches and spots, but the eggs from different nests vary enormously.

E. L. Turner

NO DANDY

The corn or common bunting is perhaps the dullest in plumage of all our birds, a fact which may account for its being so seldom noticed. Here we see a parent bird feeding its family in the nest, which is very carefully concealed in grass or herbage.

BROWN in colour, the plumage of the corn bunting is darker above than below, and streaked with darker markings. There is a pale eye stripe, the chin and throat are also lighter in colour, and the wings and tail feathers have pale edges which lighten the appearance of the whole bird. There is also a moustache-like streak running downwards from the bill.

Differing in almost every particular from the corn bunting, the linnet, the last important member of this group, is of the same build and general character as the goldfinch, described in page 321, and is in many ways more of a finch than a bunting. Like the corn bunting, it is mainly a local species, although on account of migratory movements it may be seen, at one time or another, in almost every part of the country. The name linnet is often qualified in the case of this bird with the adjectives red, grey or brown, to distinguish it from the "green" linnet, which is a local name for the greenfinch: the latter bird is in some places simply called the linnet, while the name red linnet may be reserved for the goldfinch. A character which the linnet proper shares with the goldfinch is that of sociability; the birds are to be found living in little colonies even in the breeding season, and in winter, of course, they show the usual finch character of collecting in flocks. There would seem to be something nervous in the manner of the linnet, for the birds keep up a continuous twittering.

E. J. Hosking

THE LINNET'S HOME

The neat little nest of the linnet reminds us rather of that of the goldfinch, and so, too, do its spotted eggs. Any thick bush or shrub will provide a site for this bird's building activities, and it is also very fond of the dense, clipped, roadside hedge. Grass and hair are the main materials used in this nest's construction.

In spring this is crystallized into a short, sweet song; the individual notes are pleasant, though never loud, and there are a number of rather hard—some would say, harsh—notes, which add a peculiar and readily appreciated character to the linnet's song.

Conspicuous Colouring of the Linnet

THE appearance of the linnet is as distinctive as its song, and in breeding dress the cock bird is, indeed, most handsome. The back is chestnut, warmer than that of the yellow-hammer, and the underparts are shaded from warm yellow-brown under the tail to white on the belly. The breast is a warm, bright crimson, and the same colour draws attention to the forehead and the crown of the head. The lead-blue of the beak is in sharp contrast to this, as also are the white, brown-speckled chin and

C. W. Teager

LINNET SONGSTER

More handsome than any photograph can adequately reveal, the linnet is also a pleasing songster, and a roadside perch suits him admirably when in musical mood. The conical beak, sturdy build, and rather short wings—all these are features that demonstrate his relationship to the other finches.

throat. The rest of the head is grey-brown, and the wing and tail feathers are darker brown, edged with white. The hen bird, as is usual in the finches, is smaller and has none of the bright crimson; blackish streaks take the place of the contrasting colours of her spouse, and her appearance may be described as modest.

A GORSE bush is without doubt the favourite nesting site of the linnet, and the localities in which the bird abounds, such as the heathy commons of the south of England, are those which provide ample accommodation of this kind. The nest is made of fine twigs, grass and wool, and is a smaller, neater affair than that of either the yellow-hammer or the corn bunting. The lining is of wool, hair, the down of plants and trees such as willows, and, occasionally, feathers. The eggs are bluish, with reddish or purple markings and sometimes a background of pale greyish lines. They number from four to six, and are laid in April, and there is very often a second brood. The adult linnet feeds almost entirely on seeds, but the young birds are sometimes fed on insects, although seeds, regurgitated from the crop of the parent bird, are their usual diet. The bird consorts with other finches and buntings during the winter months, coming into the cultivated fields in search of food, and little parties of migrants are often to be seen round the coast.

Another bird that may be included with the three described above is the cirl bunting. The naturalist who has but little acquaintance with birds might well be excused for mistaking this for a rather curious-looking yellow-hammer, for there is a great similarity between the two birds, which are very closely related. The cirl bunting is slightly the smaller of the two and is rather more thickly built than the yellow-hammer, and it has a certain amount of black in its plumage. In summer the male has a greenish-yellow head, streaked with brown; the sides of the face are yellow, but there is a black stripe passing through the eye, which should serve to distinguish the bird from the yellow-hammer, as also should the black of the throat. The breast is pale yellow, with a band of olive green below it, the rest of the underparts being yellow. Compared with that of the yellow-hammer, there is less red in the brown plumage which clothes the back of the cirl bunting; the rump and wings are olive-brown, and the chestnut-coloured flanks are streaked with brown.

Features of the Cirl Bunting

THIS is a local bird, confined to England and Wales, south of Yorkshire. Though fonder of trees than either the yellow-hammer or corn bunting, it is in general habits very similar to these birds, but its nest is almost always off the ground, in a bush or hedge. The nest contains more moss than that of the yellow-hammer, and the eggs are more distinctly marked with scribbles and spots. The first of the two broods is laid in May. The cock bird, whose song is like that of the yellow-hammer without the ending, sings as late as September, when there may still be young in the nest.

A bird that in many ways resembles the linnet is the lesser redpoll. This is one of those small birds that is not much noticed, chiefly because it is fully described in only a few books, and not many people realize that it is common anywhere in the country. It is, however, a fairly widely distributed species, especially in the northern counties, and is perhaps on the increase in the south. The name is aptly descriptive, for this pretty little finch has a beautiful crimson patch on its forehead, similar to that which marks the cock linnet, but darker. The breast, too, is deep pinkish in the male, and this colour shades gradually to whitish under the tail. The upper parts of the bird are dark brown, with two pale bars across the wings, and buff borders to some of the feathers on the flanks.

GENERALLY regarded as being a northern race of the same bird, the closely-related mealy redpoll is a fairly common winter visitor, distinguished by being larger and greyer, and paler; the bars on the wings and the rump are practically white. The lesser redpoll makes its nest in bushes, hedges or trees, the structure being similar to that of the linnet. The eggs are darker than those of the linnet, and are slightly smaller; the number is the same.

FERNS THAT REWARD THE RAMBLER'S SEARCH

OWING to the depredations of the unthinking collector and the chemical-laden air of our industrial areas, some of the more delicate and lovely of our ferns tend to disappear, but the species that are to be encountered in all parts of the country are in themselves so attractive, that the student naturalist need never be in want of ferny material. In pages 28–29 bracken is fully described; below we meet some of the ferns proper

THE structure of the fern, like that of flowering plants, may be divided into root (called *rhizoma* when creeping), stalk (*stipes*) and leaf (frond). The rhizoma spreading under the ground throws up stalks every few inches, and from these *stipites* the leafy portion grows. This may consist of one undivided leaf, when it is called *simple*; but it is more often divided into leaflets, and then is known as *pinnate*, each leaflet being called a *pinna* (Lat. for "feather"). If each pinna is again divided into miniature leaflets, the plant is called *bi-pinnate* and the leaflets are known as *pinnules*; and the pinnules may be themselves divided up again, when the frond is described as *tri-pinnate*, the minute segments being called *lobes*. It is on these lobes, pinnules or pinnae that we find the fern's "eggs"; called *spores*, they are contained in cases called *sporangia*, are usually covered with a little scale called an *indusium*, and together form little clusters called *sori*.

Perhaps the commonest of our ferns, other than the bracken, is the male fern (*Nephrodium filix-mas*). Its most characteristic feature is the very strong and upright stem, which in old specimens may grow to a thickness of several inches. The fronds that grow out from this stem wither yearly during the winter months, though it often happens that in a mild winter they remain upright until the spring. If the fronds are parted with the hands, a careful examination of the stem at their base will reveal undeveloped fronds, the smallest and least mature of which may not grow to their full length for several years.

FRONDS vary very considerably in length, and in a really favourable situation, where there is not too much sun and not too much shade, they often reach some three or four feet. They are *lanceolate*, *i.e.* they are broadest in the middle section and taper at the top and the bottom. Near the bottom they are *bi-pinnate*, each pinnule tapering to a fine point; at the top, where the leaves are not so fully developed, the segments are not cut to the mid-rib and that part of the frond is known as *pinnatifid*.

As with the bracken, the *sori* occur on the underside of the fronds, and only on the upper pinnules. In a healthy plant every frond is fertile, the spores being scattered by the wind when they are released from the *sporangia* in the late autumn. The actual sorus of the male fern differs from that of bracken in being covered with a kidney-shaped *indusium*. This extends not only over the cavity containing the spores, but also over the slight central swelling of the leaf tissue known as the *placenta*. With the coming of spring the new fronds begin to appear, and by the end of April they have grown to a length of several inches, and have taken on the typical "shepherd's crook" appearance.

Male fern is very variable in form, and botanists have divided it into numerous sub-species, the differences of which are mostly of a highly technical nature. It may be found in a number of different habitats, the most typical

MOST COMMON FERN

This shady corner of a wood harbours a fine collection of stout male ferns. In less sophisticated days the shiny, pale green fronds of this fern were used for making beer, medicine, soap and tea, as cattle-food, for dressing leather, and "for driving away serpents, gnats and other noisome creatures."

A. W. Dennis

OFT-ENCOUNTERED FERNS OF THE NEPHRODIUM FAMILY

Here the virile fronds, unrolling in various stages of their growth, of the male fern (left) may be contrasted with the delicate and more feminine foliage of the marsh buckler fern, shown on the right. Both species, like most ferns, prefer a damp habitat, but the marsh buckler is practically the only British fern that will flourish happily in really water-logged soil or actually with its roots and stems in the shallow waters of streams and lakes. Both male and marsh buckler ferns are deciduous—that is, lose their fronds in the winter; indeed, the latter's foliage withers away at the touch of the earliest autumn frost.

of which are rocky ground in damp river gorges and undrained woodlands. The dry soil of the chalk uplands, so suitable to bracken, does not favour the growth of the male fern, which rarely occurs in such districts except where a layer of underlying clay has caused a depression in the ground to become somewhat damper than the surrounding country. In addition to the sexual process of reproduction this fern, like bracken, also has an asexual or vegetative method, though this is not very fully developed, the rhizomes being considerably slenderer than those of the bracken and much more liable to be overcome when competing with other plants. It is for this reason that the male fern has been limited to regions where the ordinary sexual reproduction by means of a prothallus can be carried out on damp and well nitrified soil.

Of the several other species of the same genus, the marsh buckler fern (*N. thelypteris*) is, as its name suggests, very fond of damp situations, and may be found growing in marshes and on the banks of low-lying rivers and lakes. Its fronds are far more delicate than those of the male fern, the whole plant having a much more "lady-like" appearance. Some individual plants are spore-bearing, while others are infertile, these latter occurring chiefly in very damp situations. The fronds of the infertile plants are far longer than those of the fertile specimens, and sometimes reach a height of four feet. Reproduction is carried out both vegetatively and by means of spores, the infertile plants, of course, having to rely entirely upon vegetative reproduction with rhizomes. These barren fronds are very thin and are practically transparent when held against the light, so that their venation can be easily traced. The pinnules of the fertile fronds are bent under, bearing on their undersides almost circular sporangia which lose their indusia very early. The marsh buckler fern is one of the few British species which will grow in water with its stem completely below the surface. The fronds appear in spring in much the same manner as those of the male

A. W. Dennis

FERN 'EGGS'

Above we see on the underside of a male fern frond the kidney-shaped, or reniform, indusia which cover the sori until maturity, when they change from grey to reddish-brown.

fern, but they fade somewhat earlier, being withered by the very first frosts of autumn.

A further species of *Nephrodium* which the rambler may encounter in really country districts is the mountain buckler fern (*N. oreopteris*), which is found, not, as its name (from Gr. *oros*, mountain) suggests, only in the uplands, but in all districts where the soil is sufficiently rocky and of the right texture. This fern is very widely distributed throughout Great Britain, both in the lowlands and on the sides of mountains, but is especially common in the north, where, like bracken, it will often cover large areas. A rare relative of the male fern is the crested buckler fern (*N. cristatum*), the rhizomes of which are very well developed, sending up fronds at intervals throughout their length. The leaves are oblong and extremely narrow. This fern is found chiefly in very damp situations in the north of England. Another species of the buckler ferns, the prickly buckler fern (*N. spinulosum*), occurs in numerous varieties, many of which have been classified by botanists into separate species. The triangular fronds of this fern may bear leaves as much as 3 ft. in length, the rootstock being erect and very sturdy. The prickly buckler is very rare; it may be searched for with most chance of success in damp woods and on the banks of low-lying streams.

H. Bastin

ABUNDANT IN THE NORTH

The mountain buckler fern seen above is often mistaken for the male fern, but it may be distinguished by the fact that its "pinnae," or leaflets, begin to grow close to the base of the stem, while the male fern's stalk is bare for some distance up its length.

Holly Ferns of Local Distribution

FOLLOWING the male fern group the shield ferns come next in importance. All these belong to the genus *Polystichum*, perhaps the most attractive being the holly fern (*P. lonchitis*). The stem of this fern is thick and tufted, the fronds, which are curiously stiff and upright, attaining a length of about nine inches. In the Polystichums the indusium is never kidney-shaped, as in the Nephrodiums, but is circular and has a thin stalk by which it is attached to the leaf. During the development of the sporangia the whole of the underside of the leaf becomes covered with indusia. The holly fern is typical in this respect especially, for, when the spores are ripe, the undersides of the leaves become brown with the numerous indusia adhering to the tissues. This plant is found mostly in mountainous districts and is common only in the north of England and in Scotland. Its fronds are evergreen and are capable of withstanding even the most rigorous winters.

S. L. Bastin

PRICKLY ROCK-DWELLER

The popular name, holly fern, and the botanical appellation, *lonchitis* (from the Greek word for lance), of the fern seen above, refer respectively to the prickly leaflets and the pointed, spearlike outline of the fronds. The rarest British shield fern, it lives among the bare rocks, 2,000 feet or so above sea level.

THE hard prickly shield fern (*P. aculeatum*) is somewhat more common than the holly fern, from which it differs greatly in appearance, though its identification as a Polystichum is simple owing to the presence of the round indusia. The lanceolate fronds, which grow from a tufted rootstock, are stiff and upright, of leathery texture, and a dark green colour. The frond stalk is covered with a large number of brown scales and the leaf edges are serrated. The fronds

H. Bastin

SOFT AND DROOPING

The soft prickly shield fern, a clump of which is photographed above, favours most the moist hedgerows of our leafy lanes, where it covers the slopes with a graceful drapery of green. More drooping and a more vivid green than its hard cousin, seen on the right, it is one of our commonest ferns and exists in 250 varieties.

may attain a length of two feet or even more, and the fern is to be found chiefly in damp woods, where it may cover large areas of ground. Another shield fern is *P. angulare*, the soft prickly shield fern, also to be found in damp woods and on the banks of low streams. The fronds have a distinctly drooping appearance, in strong contrast to the upright fronds of the hard prickly species.

Golden and green in colour, and sometimes also a rich brown, these fronds are among the most superb examples of symmetry and regularity to be found in the fern world. Not only is each pinna a replica fern in miniature, but the pinnules are also attached to the off-shooting stems on little stems of their own, their angularity giving the fern its Latin name. They are beautifully veined, the sporangia along each side of the mid-vein being covered with an indusium that is held to the leaf by a short stalk. The stem of the fern and the mid-ribs of the pinnae are covered to an abnormal density with rust-coloured scales.

HARD AND UPRIGHT

Favouring a sheltered wood or copse, and also found in some profusion on the hedge-bank, the hard prickly shield fern, exemplified below, is frequently confused with the soft species. The rounded outer edges of its leaflets, however, are easily distinguishable from the angular tips of the other's pinnules.

H. Bastin

GROWING FERNS FROM SPORES

The art of the fern-hunter, while it requires some patience and a little specialized knowledge of the locality most favoured by certain species, can be made a fascinating pastime or can be extended to a profitable hobby as the individual desires. There is usually a steady demand in the market for hardy ferns of all kinds, and, fern-propagation being such a simple matter, there are considerable openings in fern-culture for those with a little spare time and a natural interest in how things grow.

There was a time when writers on the subject of fern-hunting began their accounts with a list of the tools that should be taken by the hunter on his expedition to the woods; they included a small hand-fork and trowel, a hammer and chisel and a large basket, and the procedure was to uproot the fern from its position in the ground or wall or rocky crevice with the appropriate tool, and carry it home in triumph in the basket. This practice has happily declined, and the modern fern-hunter is strongly advised not to burden himself with an array of implements with which to do battle with the fern. Uprooting is to be strongly deprecated; it leaves an ugly gap in the closely-woven carpet of ferns on the floor of the wood or a space like that left by an extracted tooth in the fair face of an ancient stone wall, and, moreover, it is seldom that a delicate plant like a fern, especially those species with creeping roots, can be transplanted successfully. A mark of destruction in the wood, like the footprint of a marauding beast, and a dead fern, withered and dirty-brown in a pot, are poor rewards for an afternoon's hard work with fork and chisel and basket; they give no pleasure to the depredator and only spoil for later ramblers the scene he has ravaged.

Refrain from Root-grubbing

If specimens *must* be carried away, it is best to do this in winter, and only if the species is deciduous, for then there is hope that the gap will be filled by natural propagation by next summer and there is a better chance that the fern will transplant successfully. But by far the best method to employ is to gather *spores* not *roots*; these are so plentiful that they will not be missed in the wood.

For this purpose the collector will need a flower pot, which must be half filled with broken " crocks " to supply drainage. On top of this he should place a compost of soil, either dug up from the situation where the selected species is growing, or composed of a mixture of loam, peat and silver sand. If it is possible to sterilize this soil with boiling water to kill the germs of any harmful fungi, this should be done; in any case the soil must be thoroughly watered. Next, spores are shaken from the underside of the pinnae of the selected fern on to the soil in the pot and a piece of glass placed over its mouth, to prevent the spores from blowing away and at the same time to provide light.

At home the collector should keep his spores in a dark place—in a cellar or the cupboard under the stairs—occasionally lifting the glass for the purpose of ventilation, but only for a short time and when there is no draught, and wiping condensed moisture off the glass when he does so. Watering is, of course, essential to the spores' growth, but should not be done from a watering-can on the surface. Instead, the pot should be placed for several minutes in two or three inches of water in a bath or sink, the water soaking up through the hole in the base. Thinning-out may be practised if the little ferns that soon begin to appear are too thickly clustered, the removed plants being transferred to another pot. This method of fern-culture is, of course, a slow one, but is far better than uprooting.

SANGUINARY HUNTERS ON A NOCTURNAL TRAIL

LIKE a stoat in appearance and in many of its ways, the weasel may readily be distinguished if attention is paid to the details listed below. For purposes of comparison, reference should be made to the chapter on the stoat (page 261), and to those on the pine marten and polecat in later pages. All four animals are closely-related members of the Mustelidae

THE weasel (*Mustela nivalis*) is a sort of small stoat. It has a similar elongated body and snake-like head, and, again like the stoat, preys voraciously upon the smaller beasts of the field. The difference is mainly a matter of size, since the weasel measures some nine or ten inches in length from snout to tail compared to the fourteen inches of the stoat. In addition, the tail of the weasel is proportionately shorter, and is without the black tip characteristic of the stoat. The colouring of the weasel is also similar to that of the stoat, though the fur is of a deeper russet colour and the belly a purer white and, moreover, the British weasel rarely turns white in the winter. The head is somewhat narrower and more snake-like than that of the stoat, but the dentition is the same, namely:

$$i\,\frac{3}{3},\ c\,\frac{1}{1},\ pm\,\frac{4}{4},\ m\,\frac{1}{2} = 38$$

The weasel is generally distributed over England, Wales and Scotland, but is absent from Ireland, the animal that is found there and popularly called by that name being the Irish stoat.

Weasels produce two litters in a year, pairing in January and bringing forth their first brood in April. A second brood may be produced in July. The young weasels are born blind, but covered with fur, and they remain dormant in the hole that the mother has dug for them or in some disused rabbit burrow she has selected, for only a comparatively short time before they are able to emerge and savour the outside world for themselves. Four is the usual number of cubs in a litter, and, like the young of all predatory mammals, small weasels are very active and play prettily together like kittens. Watching these gay little creatures at play, one can hardly realize that they are some of the most bloodthirsty of Britain's mammals, and that their antics, which are a sort of mimic warfare, may readily be changed to a battle in grim earnest—that the small, alert face may easily become a mask of fury, the lips drawn back, and the fangs bared.

The weasel is less frequently seen than the stoat, since its activities are more generally nocturnal than those of its larger cousin, though occasionally it may be glimpsed

WEASEL VENERY

The weasel is a smaller cousin of the stoat and may be recognized by its smaller size and also by the fact that its tail, which is shorter and less bushy, is without a black tip. This photograph shows a weasc. dragging its prey, a sparrow, through the undergrowth.

H. Mortimer Batten

H. S. Berridge

WHITE FOR WINTER

Although white weasels are common in more northern countries, and weasels with partially changed coats may be found in Scotland, it is rare for a completely white weasel—such as is seen in this photograph—to be found in our islands.

darting rapidly across a road or hunting busily along the hedges and ditches. Its prey consists mainly of such small creatures as voles, mice and shrews, and the animal is found more often in lowlands, where such prey abounds, than in highland country. In seeking its prey, however, it is never deterred by considerations of size, for it will kill rats, which, besides being fierce fighters, are considerably larger and heavier than itself, and drag them long distances, and will even attack rabbits and chickens successfully. For its size and weight the weasel is probably the most formidable animal in the British Isles, since it lacks neither strength nor courage.

Weasels on the War-path

Its methods of attack are worth noting. Where the prey is a rat, mouse or small bird, the weasel will jump upon its victim and make a bite at the base of the brain, which leaves it paralysed and helpless. In the case of larger game, where it is unable to adopt this method, it will seek to bite through the main blood vessels—those in the neck of the rabbit, and those which run under the wing of larger birds, like the chicken. The stories of the weasel sucking the blood of its victims are probably based on its procedure in tackling the rabbit, when it will bury its fangs in the neck of the unfortunate animal and hang on until the death struggles have ceased. The brains of the victim are its favourite food, but it will eat any part of the body if it is hungry, and will not disdain carrion in cases of necessity.

It must not be thought, however, that the weasel is a great pest, even though it may take an occasional rabbit or chicken. The gamekeeper quite justifiably shoots any weasel he sees near his pheasant coverts in order to protect the young birds, but this small carnivore is a benefit to the farmer, since it destroys the rats and mice which injure his crops.

One curious point about weasels is that they sometimes hunt in packs. It has been thought that these packs are family parties, comprising the mother and father and the litter, but the cleverness shown by them in pursuing and catching prey suggests that they have been formed for the express purpose of hunting. These packs are not common, but when weasels thus band together their ferocity and cunning seem redoubled, and they have even been supposed to be unafraid of Man.

Although it can see well, the weasel depends almost entirely upon its sense of smell when following its prey. Once on the trail, it will keep its nose to the ground and raise its head only when it is checked and seeks to cast about until it can find the track, or when the end is near. These lithe bundles of sinew, bone and fur are greatly helped in the pursuit of their prey by their small size, and many an unfortunate rodent is trapped helpless in its burrow when its deadly enemy enters. In addition, the weasel is extremely active, and not only can it climb trees and so raid birds' nests, destroying young and eggs, but it can also swim strongly in pond or river. It has a curious method of progression through the water, swimming with its neck and shoulders high out of the water and its back strongly arched.

Further to aid it in the struggle for existence, the weasel possesses great cunning. It has been said that, in order to fascinate its prey, it will perform the most extraordinary antics, standing erect and dancing on its hind feet, emitting little coughing grunts, and generally performing a *danse macabre*, until it is enabled to come within distance, when it will make a sudden spring at its bemused victim. This is one of several points in which the weasel superficially resembles the snake, others being the length of its sinuous body and the viperine shape of its head.

Another reason for the weasel's efficiency may lie in the fact that it is a comparatively late development from the main "tree of evolution." Remains of weasels are found in cave deposits in Yorkshire and Devonshire, but have not been traced in earlier formations—facts which would indicate that the weasel is indigenous to our island, but is quite a recent offshoot from the great order of carnivores, which includes the lordly lion and the homely cat.

When all the qualifications of this interesting little animal are summed up it can readily be understood how the weasel, despite the warfare waged upon it by the gamekeeper and often the farmer, has been able to hold its own and continue to live plentifully in the land, when its larger relative, the marten, has become so scarce.

MOTHS OF THE TIGER AND ERMINE FAMILY

CONTINUING our study of British moths, we are introduced below to the most important members of the tigers and ermines: the garden, cream-spot, wood, ruby, scarlet and Jersey tigers, and the white, buff and water ermines. Particular attention is paid to the "woolly bears"—i.e., the caterpillars of certain tiger moths. Several of the moths dealt with in this chapter are included in the colour plate facing page 435

THE caterpillars of some of the members of the family *Arctiidae*, and especially those known as tiger moths, are given the name of "woolly bears." The reason is obvious, for they are clothed with a fine coating of long, silky hairs, which in some species cover them so completely that they look like animated balls of black wool. The moths themselves have earned their name for an equally obvious reason, since their bright reds, yellows and blacks are arranged in spots, stripes and bands across the wings. A smaller section of the same group contains the ermine moths, and here, again, we can see at a glance how they got their name, for their colour scheme consists of a number of black spots on a light background.

Attractive Colouring of the Garden Tiger

PRIDE of place among the woolly bears belongs to the caterpillar of the garden tiger moth. Not only is this the commonest, but it is the woolliest and the best-known of them all; it is, in fact, to this caterpillar that the name woolly bear is more strictly confined. The moth is perhaps the handsomest member of the group. It may often be found at rest among the herbage at the base of a hedge, where its bright colouring shows up surprisingly little, thus affording an example of daring colours serving the purpose of camouflage so long as the insect remains still. White is the general colour of the fore-wings, but the white is so marked with brown—in a pattern that leaves white stripes running backwards from the fore margin as well as outwards from the inner area of the wings—that brown might almost be taken for the ground colour. The rear wings are bright vermilion, with two rows of fine blue-black spots, usually larger and more numerous in the female. The inner row may consist of a single spot near the base of the wing, while the outer row has three or four spots near the margin. The whole arrangement of these colours varies enormously, so that one may find specimens in which the fore-wings are almost entirely either brown or white, while the spots on the hind wings may either be almost completely absent, or may cover practically the whole wings. The wing-spread of the male is a little over two and a quarter inches, while a fine specimen of the female may be three inches across.

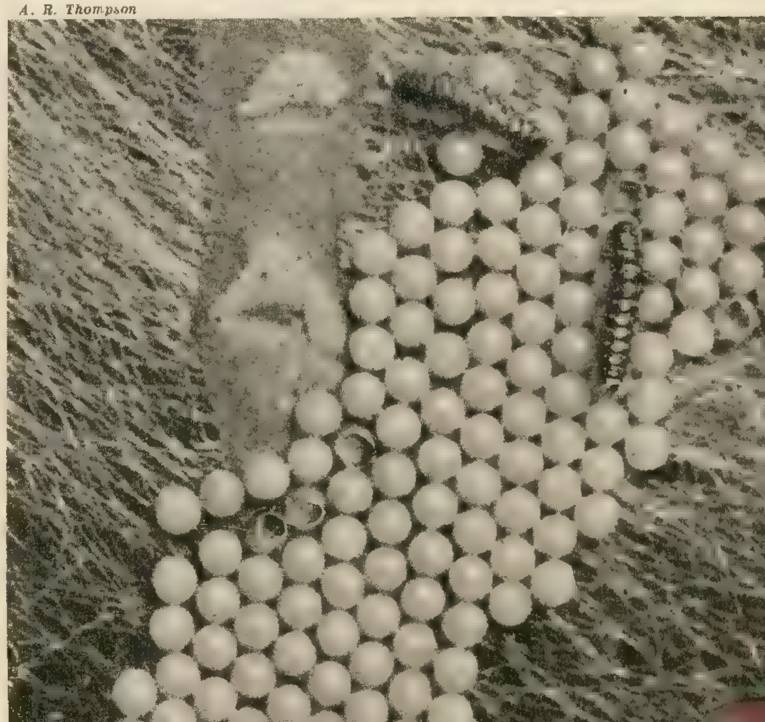
THE caterpillar of the garden tiger is black when fully grown, although this colour can scarcely be discerned beneath the mat of long grey and brown hairs which give it its name. Found all over the country during the summer months, it feeds on almost any low-growing herbage, and is specially partial to such plants as nettles, dandelions and docks. It weaves a largish cocoon of silk at the base of its food plant, and strengthens this with the hairs of its own body. Within the cocoon the caterpillar turns into a chrysalis, and if the cocoon is opened the cast-off skin of the caterpillar will be found adhering to the end of the pupa. The adult insects are about in July, when they may be seen sunning themselves on hedges, and the caterpillars hatched from their eggs hibernate and finish growing up in the following spring. The garden tiger is extremely easy to rear, and if a large number of caterpillars are selected and bred up quickly indoors, it is often possible to get two broods in a year. By breeding from moths that show the most outstanding variation in markings—such as a great deal of brown or an abnormal amount of white—a further generation may be obtained which will show these variations to an even greater degree. This process may be carried on until a really fine range of varieties is secured, and if full notes of this breeding experiment are taken and the specimens are properly written up, we may find ourselves doing evolutionary research of real value.

ONLY one other of our tiger moths is really common in any part of the country, and that is the cream-spot tiger. The ground colour of the fore-wings is black, often with a distinct greenish or bluish sheen, and spotted with cream. The arrangement of the spots varies, as does their number and size. In general there is one double spot at the base of the wing, and two rows along the fore

EMBRYO TIGERS

Newly hatched from their eggs, as the empty shells denote, these two larvae (× about 7) of the garden tiger moth are already on the search for food, while their fellows rest as yet in their tiny cells. Notice the shining black skins and long, bristly hairs.

A. R. Thompson



J. J. Ward

'WOOLLY BEARS' AT SUCCESSIVE STAGES OF THEIR EXISTENCE

In the left-hand photograph above are seen caterpillars of the garden tiger moth not very long after they have hatched from the eggs; they are probably in their second skin. In spite of their small size, they have practically demolished the leaves of their food-plant, a species of dead nettle, and they are clinging to the bare skeleton of veins which they are too small to tackle. In the right-hand photograph they are fully grown and ready to pupate, and it is now easy to see why they received the children's nickname of "woolly bears." The not yet quite full-grown individual on the right, hurrying quickly along, is stretched to full length, with the result that the long hairs are separated and the woolly effect is not so obvious. (Natural size.)

and hind margins respectively, culminating in two very large spots, beyond which there is a further single spot; but the arrangement does not even correspond strictly on the wings of the same insect. On the hind wings the grouping of light and dark is more or less reversed; the ground colour is rather rich orange-yellow, with a few small black spots in the central area and several large ones near the margin. As in the garden tiger, the female usually has larger spots and more of them. The size of the male across the wings is two inches, and of the female slightly over two and a quarter inches. The larva is fond of almost any low-growing plant, although it has a distinct partiality for dandelion. When full-grown, it is black, with brown hairs arising from warts on each ring of the body, giving it a less woolly but more bristly appearance than the "woolly bear." The manner of pupation is the same as in the garden tiger. Although it is subject to a fairly wide range of variation, the cream-spot tiger will give the breeder nothing like so wide and interesting a series of specimens as the garden tiger.

Waters; Thompson, Ward

MARKING VARIATION AS EXEMPLIFIED IN THE GARDEN TIGER MOTH

One of the most variable of all our moths, the common or garden tiger derives its name from the striped appearance of its fore-wings. Some idea of the range of variation commonly found may be gathered from these three rather more than life-size pictures. The white markings are relatively small in the left-hand specimen, especially those at the bases of the fore-wings. In the second picture this marking is larger, sending two branches along the wings. The third (right-hand) picture shows an individual in which these two projections along the wings have joined up with the markings that run across; in the brown square thus formed two new spots of white have appeared. Other variations in the markings may also be readily discerned.

M. H. Crawford

BRISTLY YOUNGSTERS

Supported solely by the long, strong bristles that cover their bodies these two caterpillars of the cream-spot tiger moth look decidedly strange. Their small size can be appreciated by comparing them with the egg itself, about 18 times life-size.

The third species to be dealt with here, the wood tiger, is a much smaller insect than either of the two preceding, its wings not measuring more than one and a half inches from tip to tip. Here, again, the general colour is blackish, with cream, yellow or almost white markings on the fore-wings. The chief of these is a stripe that runs above the hind margin, coalescing at its outer end with the lower members of the series of markings which takes up the rest of the wings. In the hind wings the ground colour is darker yellow or orange, with black markings on the inner area. There is a great deal of variety in the colour of the markings, which may be anything from whitish to quite distinct red, and also in their arrangement, and the amount of black on the hind wings varies enormously. The caterpillar is black, with black hairs arising from grey warts, but on rings four to six the warts and hairs are reddish. It feeds on low-growing plants and has a preference for forget-me-nots. The wood tiger is not by any means confined to woods. It is found principally in woods that have a fair amount of herbage and undergrowth, especially of heather, but moors, heaths, and the valleys of the chalk and limestone hills are also favoured sites, and its relative commonness has been rather discounted by the large size and conspicuous colouring of the two species described above.

Smallest of the Tiger Moths

ANOTHER of our species of tiger moths, the ruby tiger, frequents somewhat similar situations to those in which the wood tiger may be found. It is very different in appearance from any of the other species, and it is also the smallest of our tiger moths, the wing expanse being about an inch and a quarter. The fore-wings are of a curious reddish-brown colour, very soft in tone, and are semi-transparent. The hind wings are greyish-blue, but the inner areas are suffused with the warm red from which the insect gets its name. There is a little black marking in the centre of each of the four wings. The body also is red, with black spots down the middle, but the thorax is brown. In specimens from the north of England the reddish colour is absent from the hind wings and the abdomen is almost entirely black. This little tiger is not very noticeable, and, though widely distributed, is nowhere abundant. The caterpillar, in common with those of the species already described, feeds on low-growing plants, and is very partial to the wild golden-rod—not to be confused with the very different garden plant of the same name. Black hairs cover the larva, which has a reddish line along the middle of the back and a few reddish spots on the sides.

TWO other species of tigers are found in the British Isles, namely, the scarlet tiger and the Jersey tiger. The scarlet tiger is in many ways similar to the cream-spot tiger, but the colour scheme is rather brighter. The front wings are more distinctly greenish, and the two innermost spots near the fore margin are crossed by a band of orange. The hind wings are bright scarlet, with blackish-blue spots, and the whole moth is so brilliant that it looks more like a rarity from the tropics than a member of our usually rather sombre moth-fauna. Found chiefly on marshy ground, the scarlet tiger is confined to the southern part of the country, and only in Kent is it at all common. Varieties are fairly frequent in which the hind wings or the spots on the fore-wings are yellow. The caterpillar is black with rows of yellow spots down the back and along the sides.

The Jersey tiger is more deserving of the name tiger than any of our other species, since its dark fore-wings are crossed by diagonal white or yellowish stripes instead of the usual spots, which are, however, present on the

J. J. Ward

SCARLET TIGERS

The scarlet tiger is one of the less common members of its group, though it may be met with not infrequently in the south of England. The spots on the wings vary considerably, and some of them are somewhat paler than the rest. (Natural size.)

pale scarlet hind wings. This is a rare moth, found chiefly in Devonshire, where it probably established itself by introduction or migration from its headquarters in the Channel Isles.

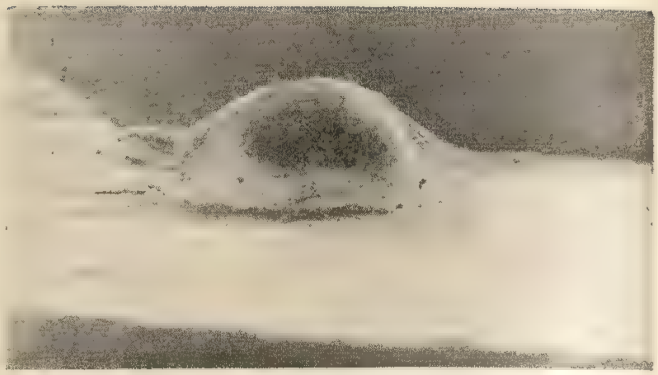
Of the ermine moths, the white ermine is much the commonest. Its dull white fore-wings are sprinkled with black dots, which, in different specimens, may be absent or may be present in greater numbers than the normal, so that this moth retains the family reputation for irregularity. The hind wings are pure white, with only two or three spots. In specimens from Scotland the fore-wings may be decidedly yellow, and the rear wings smoky. The abdomen is always yellow. The caterpillar is a typical "woolly bear"—brown, covered with very long hairs, and with a red stripe down the back. It shows the family fondness for low-growing vegetation, and in some years is so plentiful as to be a nuisance in the kitchen and flower gardens.

ANOTHER common species, the buff ermine, has the fore-wings buff-coloured, with spots arranged in a diagonal line from the apex backwards. The rear wings are paler with fewer spots, as in the white ermine, and the abdomen is yellow with black spots along the back. The larva is brown and very hairy, with a pale stripe along each side and a red line down the back. This species shows enormous variation, the spots on the fore-wings often being considerably enlarged and lengthened, until in extreme

HANDSOME BUFF ERMINES

The buff ermine is a rather striking moth, especially when newly emerged from the pupa, as are the two specimens shown below. The pattern formed by the wing markings when the moth is at rest makes it an easy insect to distinguish, even in a photograph, from the white ermine shown in the adjacent column. (× 1½.)

J. J. Ward



WHITE ERMINE STAGES

The top picture (× 1½) above shows the cocoon of the white ermine moth; the dark form of the chrysalis may be discerned inside. In the lower photograph (× 2) a fine individual of the adult white ermine is seen at rest. Its pure white, black-spotted wings are obviously responsible for the insect's name.

cases the whole wings are black—except for the veins, which remain whitish—with a whitish patch in the inner part of the fore-wings.

A moth that is local, but common where it is found, is the water ermine. This species is very similar to the white ermine, but the wings are pure white, except for two or three spots on the fore-wings of the male and a single spot on those of the female. The body is yellow. There is little variation in this species. The caterpillar conforms to type and feeds on low-growing plants in the marshes and river meadows; summer floods bring the larvae to the tops of the stems, where they are so conspicuous that the collector can save himself the trouble of long searching in the depths of the herbage.

FINALLY, we have the muslin moth, a species in which the female is intermediate in appearance between the water ermine and the white ermine. The male, however, is brown or black, a curious fact when one compares it with the other members of the family in which the sexes are practically identical. The muslin is widely-distributed throughout England, though nowhere noticeably common.

WINGED 'TIGERS'

The "tigers" of the moth tribe are so called from their tiger-like markings and not on account of any ferocious trait in their disposition. Those seen in this photograph are about twice life-size

F. Jefferson

PARENTAL SOLICITUDE

In both these photographs the predominating note is the same—obvious concern for the not-long-hatched young. Above, a cock linnet seems to be discussing baby-lore with the hen, whose fluffed-out feathers conceal the youngsters of the family. Below, parent yellow-hammers mount guard over the nest in which lie their newly-hatched brood. In the beak of the hen bird—more sombre-hued than her spouse and distinguished from him by the fact that she lacks his feathery crest—is food for the ever-hungry chicks

A. R. Thompson; Mortimer Batten

THE WIDE-AWAKE WEASEL

Weasels are so keen-witted and quick-moving that a fleeting glimpse of the lithe little body is all that the rambler may expect to see. As befits their hunting preoccupation they are ever on the alert, and the weasels seen in these photographs are poised ready to spring, their eyes, ears and noses all straining to catch the first hint of the approach of possible prey. If these pictures are compared with those of the stoat in pages 261-263, it will be seen how much alike are the two animals, but the weasel is the smaller, and its tail has no black tip

SLENDER SPRUCE

Growing so close together that their boughs meet and almost interlace, these young spruces still reveal the outlines of "Christmas trees," endeared to childish fancy

'CHRISTMAS TREES' IN BRITAIN'S WOODS

FROM our childhood days we are all acquainted with the spruce, even though to us it is known not by that name but as the "Christmas tree." For generations it has served its purpose—has been dug up, loaded with toys and candles, and placed where it may best be seen by the admiring eyes of the youngsters. But when the Christmas tree grows up, it is still worthy of our attention, and in this chapter its most prominent features are described. Some other conifers are dealt with in chapters beginning in pages 21, 240 and 368

NORMALLY it is some feature of their adult maturity that has given most well-known British trees their popularity; it may be to the blossom, as in the case of the cherries and the horse chestnut, or to the rugged grandeur of the bole, in such examples as the oak and the cedar of Lebanon, or it may even be to the quality of the shade, as in the beech and lime, that the tree owes its fame. The spruce, however, is remembered for none of these adult features, and, indeed, after it has passed the age of a few years, it may never attract our attention again. It is in its youth that it is best known to us, for the spruce, when it is young and dainty, is the Christmas tree of our childhood days.

Every year hundreds of thousands of young spruce trees are dug up, planted in tubs, and carried indoors to act as the centre-piece of the Christmas festivities. In many places only the ends of branches or the tops of larger spruces are used, but the true Christmas tree should be a real young tree, growing in its own piece of native soil. It should be planted again in the forest or garden when the festive season is over, to grow to maturity, for as a mature tree the spruce can compare with any that are to be found in the British Isles, both in beauty and in stature, although in this country it does not grow to its full size. In its native forests in northern Europe, where it is one of the principal forest trees, it may grow to a height of 170 feet and have a girth of nearly 20 feet, but with us from 80 to 100 feet is a more usual height, the girth of the bole being then about nine feet. If these dimensions are compared with those given in the chapters on, say, the elm (page 144), the oak (page 79) and the beech (page 51), it will be found that the girth of the spruce is much less, in comparison with its height, than theirs. Indeed, its stem is very fine, straight and gradually tapering, and, when we see the tree growing, this is one of the first features to strike us. In contrast to many trees, the spruce grows slowly for the first few years of its life, but then it shoots up at the rate of two feet or more every year.

THE tall, slim spruce has what is best described as a spire-like profile; it is not so noticeably pyramidal as the larch, and yet it terminates in a definitely pointed top. The branches, which grow very thickly the whole length of the tree, are not so long in proportion to the tree's height as those of the larch, so that for a great part of its height the spruce is often almost parallel-sided. They grow out almost opposite each other in more or less regular whorls, and their minor branches do likewise. The bark of the bole is grey-brown, and it separates in fairly large flakes, but higher up the tree it is more homogeneous, and is not divided into scales. The bright green leaves, or needles, are from a half to three-quarters of an inch in length, and are four-sided, ending in a very sharp little point. They cover the twigs with a dense cloak, unlike the bunches of the Scots pine, or the neat rows of the silver fir, a closely related conifer which is described in a later page, and they remain on the tree for six or seven years. When the needles drop off they leave small, sharp scales, which are turned backward and may severely scratch the hands and face of anyone who climbs the spruce to examine a bird's nest.

Classification of the Spruce

CONSIDERABLE controversy has arisen among botanical systematists concerning the true classification of the spruce; one authority calls this tree and the silver fir *Picea* and *Abies* respectively, while another reverses these generic names, naming the spruce *Abies* and the silver fir *Picea*. It is now generally accepted, however, that the truest appellation of the spruce is *Picea excelsa*, and the

SPRUCE SPRAY

The spruce's delicate leaves or, as they are better called, needles, are arranged along the twigs, which they cover with a thick coat of greenery throughout the year. This photograph well shows the innumerable needles and the way in which the twigs fork and branch and fork again.

E. J. Hosking

H. Bastin

CATKINS AND CONES

The flowers of the spruce, both male and female, are borne in catkins. Those of both sexes stand upright, but when the fertilized female catkin has become a cone it hangs downwards, as is seen in the above photograph.

specific name *excelsa*, which refers to the tree's great height, can give no cause for argument. Whatever the disagreement concerning the best names for these two species, one thing is certain; they are both fir trees, as opposed to pines. The pines, as is explained in page 240 are members of the genus *Pinus*, and are not firs.

One of the features of the spruce that distinguishes it from the silver fir is the nature of its cones; these in the spruce are long, almost parallel-sided for a great part of their length, and *pendulous*, that is, they hang downwards from the ends of the stalks, whereas those of the silver fir stick upright from the sides of the stems. The male flowers, or catkins, of the usual coniferous type, are borne in small terminal clusters on the young shoots. They are yellow-pink and about three-quarters of an inch long, and are usually found in bunches of two or three. The cones when full-grown are between five and six inches in length and one and a half inches broad. They are covered with a very large number of pale brown scales, which are thin and overlap loosely, so that the cones are not tight and compact as pine cones are. Each scale in the spruce cone conceals two seeds, which have each a transparent, pale brown wing, about five times as long as the seed. A single cone may contain several hundred seeds. One point in which the spruce differs considerably from the pines is that the flowers appear in May and the seeds are ripe in the following spring, so that the period from flowering to ripening is one year, not two years.

Interlinked Roots Make for Disaster

Shallow, spreading roots, just beneath the surface of the soil, are characteristic of the spruce. In the pure spruce forest the roots of neighbouring trees interlink to form a wide network, and though this may make a firmer footing for the trees during a moderate storm, it leads to disaster when the wind is the victor. The sight of whole rows and blocks of spruces lying broken and torn is one that often greets the traveller on the Continent after an especially severe storm. Even a sudden gust, if it be of sufficient violence, may do more damage in a spruce forest than ten stormy winters in a wood of Scots pines. The spruce is, indeed, the least able of all the firs to withstand the force of the elements, as many a timber-grower has discovered to his sorrow.

His loss is all the greater because the spruce is one of the most

SPRUCE DETAILS

To the right is seen a shoot of the spruce, its upper needles stripped to show the little scales that appear below each needle, and also the buds which will give rise to next year's growing shoots. Below, greatly enlarged, are female (left) and male (right) catkins.

valuable of all trees grown for timber. Its tall, straight trunks make masts for small sailing vessels, scaffold poles, ladders and telegraph poles, and are cut up into planks, when the lightness, close graining and enduring qualities of the wood add to its value. The fibrous wood, reduced to pulp and " digested," makes paper, and resin and pitch are other valuable products. The spruce is one of the timbers that is known to the merchant as deal—it is, in fact, " white deal." It is, of course, most valuable when it is grown to a regular size, and for this purpose it must be grown in properly kept plantations. There the trees soon lose their lower branches, in the same way as the larches described in page 23, and they do not grow to the stature of the trees of the wild forests. On the Continent vast tracts of country, especially in mountain districts, are covered with spruce, which will readily thrive as high as 6,500 feet above sea-level.

Spruce Trees in Prehistoric Times

In the British Isles the spruce is less popular as a timber tree, but it has been planted for some centuries on account of its ornamental value. It was certainly introduced prior to 1548, for an author of the time mentions it as being found here at that date. A further interesting fact is that, although there is no recorded evidence of the tree growing indigenously in historic times, we know that it did grow in the British Isles many

FOREST BOLE

In the forest the spruce loses its lower branches early, and those that do not drop off soon die. The example illustrated below is not in a very thick wood, but, nevertheless, the few small branches remaining low down are already bare and leafless

E. J. Hosking

H. Bastin

THE CHRISTMAS TREE

Though very much larger than most of the Christmas trees that we are likely to see indoors, this young spruce has not yet outgrown the shape that is so typical of the gift-bearing spruce of the children's parties at the festive season.

millions of years ago, for the upper Tertiary beds afford plenty of evidence that there were spruce trees here when they were formed.

The description and remarks in this chapter apply only to the common spruce, *Picea excelsa,* which is better known as the Norway spruce. There are also, it must be realized, many other spruces, especially in Canada, and specimens of them may be found in gardens and parks in various parts of this country. But the Norway spruce is the only one that has managed to thrive in what may justly be called a wild state. In so far as British plantations are concerned, besides being one of the trees that is most favoured by the Forestry Commission as a subject for plantations, it is also used as a nurse for other trees, as shelter-hedges for fruit gardens, and as cover where game birds are bred. One other advantage it has over other conifers: it seems better able than any of them to stand the smoky atmosphere of large cities.

TUNNY ROVERS OFF OUR EASTERN COASTS

ONLY a few years ago the presence of tunny in British waters went practically unnoticed, though in the Mediterranean the great fish have been eagerly sought for centuries as welcome additions to the food supply. In 1929, however, as will be seen from what follows, tunny fishing in British waters was begun, and has since developed apace. Details of the tunny, of its near relations, and of tunny fishing technique are given below

THE tunny is a gigantic member, sometimes exceeding nine feet in length, of the mackerel family (*Scombridae*), its other near relatives being the considerably smaller long-finned tunny or albacore, the bonito and the pelamid. Like its small cousin the mackerel, the tunny is beautifully shaped, the stream-lining of its body and fins showing how perfectly it is adapted for swift movement through the water. Since the tunny is a predatory fish, speed is necessary to it as an aid to the pursuit and capture of the smaller fishes which form its food supply.

Except in the matter of size, which at first would seem to preclude relationship between the two fish, there is a strong resemblance between the tunny and the mackerel. That this resemblance has long been noted is shown by the Scandinavian name for the tunny, which is *makrilstörje* (great mackerel), a word which has found its way into our language in the form "mackerel sture," used in Scotland to denote this fish. The chief differences between tunny and mackerel, apart from that of size, lie in the tail, which is keeled in the tunny; the dorsal fins, which are longer and closer together in the tunny; and in the corslet of coarse scales, which is absent in the mackerel. There is no likelihood of tunny and mackerel being confused, for whereas the average weight of mackerel is about three-quarters of a pound, a large tunny may weigh as much as 1,000 pounds.

The question of size is no small difference, for it shows how closely related fish can vary, the variations being due to the adaptations which are best suited to the fish's habitat. In the case of the mackerel and tunny, both are adapted in shape and line to lead a fast-swimming predatory existence, but whereas the mackerel is best fitted to prey on small fry, the tunny can feed off shoals of bigger fish such as the herring and the mackerel itself.

These great fish lead a roving life, following the shoals of small fish on which they feed, and changing their grounds seasonally. For this reason tunny have a very wide distribution, and are found along the northern coasts, warm and temperate on both sides of the Atlantic, coming inshore in summer when the weather is warm, and moving out to sea in the winter time. The western races occur along the American seaboard from Nova Scotia to Florida. The eastern races of tunny winter off the Spanish coast, far out beyond the 500-fathom limit, but approach shallow water in the spring, when they split up into two parties, one of which enters the Mediterranean, while the other follows the warm

W. S. Berridge

LONG-FINNED ALBACORE

The long-finned tunny or albacore (above) is a members of the tunny group that occasionally wanders into British waters. It may be recognized by the relatively great length of its pectoral fin; its other fins are likewise of proportionate length. Its outside length is 3 ft.

STRIPED BONITO

The bonito or stripe-bellied tunny (below) is another rare visitor to British waters. It is about 2 ft. 6 ins. in length, and its most characteristic feature is the four dark lines extending along each side of its belly.

currents northwards and travels up to the North Sea. It is these latter fish which are seen off our eastern coasts, between the north of Scotland and Scarborough, pursuing the herring on their southward migration in the autumn.

The tunny has long been held in high esteem by Mankind, and its value as a food fish has been praised since the time of Pliny. In the Mediterranean tunny fishing is of great antiquity and has grown up to meet modern needs by the development of a prosperous canning industry. It is surprising, therefore, that, although the tunny's presence in British waters has been suspected for many years, it is only recently that any attempt has been made to catch these fish.

Characteristically enough, the impetus to further inquiry came neither from scientific nor from commercial sources, but from a group of enthusiastic big-game fishermen. Prior to 1929 little was known of British tunny except for the fact that they were sometimes seen by fishing fleets and that an occasional specimen was washed ashore off our east coast; in that year the first tunny fishing was attempted, and, though no fish were landed, sufficient evidence of their presence was obtained. In 1930 Mr. Mitchell-Henry had the honour of landing the first tunny to be caught on rod and line in British seas, and since then the sport of tunny fishing has made great progress in this country. Each year a number of these giant fish are caught by sportsmen; already a British fisherman holds the world's record for the heaviest fish caught on rod and line (851 pounds, caught by Mr. Mitchell-Henry), while a British tunny club has been formed which has its headquarters at Scarborough.

Technique of Tunny Fishing

EXCEPT for some of the sharks and the larger skates, there are no big-game fish in the British Isles, so that the discovery of the possibilities of tunny fishing has opened up a new chapter in the history of sport. The method of fishing is extremely exacting, and though the sport is beyond the means of the average visitor to the seaside its importance merits description. Briefly, the plan is to put out of harbour in a small motor-boat, towing a dinghy behind. The expedition should set out between midnight and three in the morning, and the objective is the spot where the drifters are operating. If the day is to be successful the drifters should be located as the first pale light of dawn creeps across the horizon, since the drifters pull in their nets as soon as it grows light. Afterwards, the herring trawlers may be sought for, but it is the drifters which give the first chance to the tunny fisherman.

The fisherman and a companion are cast loose in the dinghy, while those in the motor-boat wait attendant upon them. If the approach of tunny is seen, bait in the form of mackerel is thrown overboard to attract them to the vicinity of the dinghy.

AS the tunny draw near, the water will boil with the fury of their swift movement through the water. The baited hook is then thrown overboard and the fisherman waits, intensely eager for the moment when he will feel his bait taken. Most likely his baited hook will be left untouched, but if it is snatched by one of these monster fish there is plenty of excitement in store for those in the dinghy. The line will be taken out with a rush and the reel will scream with the speed of its revolutions. If the fisherman is successful in keeping his line intact during this initial period of the contest there is sure to be a long fight; for many hours he will have to battle with the giant fish, checking its rushes and contesting every yard of line. Even when it is killed the fish may die deep down, and it will need considerable skill and strength to bring it to the surface.

During the whole of the period during which the fish is being played the fisherman is seated in the dinghy, the butt of the rod firmly fixed in a socket designed for it, while additional support is given by a harness suspended from the fisherman's back and shoulders. The line must

CAPTURED MONSTER

For the past few years, the true tunny has been an object of interest to the big-game angler. This photograph shows the giant size of a fine specimen caught off the Scarborough coast. Note the general resemblance, but the difference in fin length, between it and two other members of the tunny family, albacore and bonito, illustrated in the opposite page.

TUNNY TACKLE

This photograph shows the tackle used in tunny fishing. Note, particularly, the large size of the rod and reel and the safety catch projecting above the fisherman's right hand. This is pulled if there is any danger of the man being dragged overboard, and instantly frees him of his harness.

be a strong one to stand the strain of the conflict, and the fisherman himself must be careful to avoid being swept overboard by the monster's rush. He must be prepared to lose tackle, line, and even rod itself rather than risk being pulled into the sea and towed in the fish's wake.

Since a tunny is capable of towing a boat at a speed of between four and five miles an hour, it will be realized that tunny fishing is an arduous and exacting sport which demands a high standard of fitness in its devotees.

Although tunny are caught regularly in the late summer and autumn of each year, there is, as yet, no industry for the disposal of the fish. Tunny fish as a food does not seem to appeal to the people of the British Isles as it does to those of the Mediterranean.

Other Members of the Tunny Family

No attempt has as yet been made to catch the other members of the tunny family, partly because they are smaller and have less appeal, but largely on account of their comparative rarity. The long-finned tunny, or albacore, may be distinguished by the great length of its pectoral fin, which measures a third of the fish's total length, and the pelamid, or short-finned tunny, by the banding on the upper surface of its body; while the bonito, or stripe-bellied tunny, is rather smaller than the others.

Although little or no attempt has been made to catch these last fish in British waters it is quite possible that, since the discovery of tunny fishing as a British sport, they may come in for a share of the angler's attention.

The study of marine fish always presents great difficulties owing to the impossibility of seeing far into sea water, and also on account of the vast areas over which many fish travel. Hence any source which provides fresh information is a blessing, and the angler and sportsman are the assistants of the scientist in this connexion.

FORCED TO THE SURFACE

The sight of a tunny breaking surface must bring a thrill to the beholder. The photograph below shows a tunny which is lying just beneath the surface, having been brought close up after a long battle with the angler. This moment is the fisherman's prelude to triumph in his arduous sport.

LITTLE-KNOWN FACTS ABOUT THE SLUG FAMILY

SLUGS and snails are so closely related that it is impossible to draw any hard and fast line between them. It is true that in popular belief snails have shells and slugs have none, yet, as will be seen from what follows in this chapter, all the nineteen species of British slugs have rudimentary shells exposed to a greater or lesser degree. Though it can hardly be claimed that slugs are attractive creatures, a study of the various forms introduces us to a comparatively unexplored field of animal life

THERE are few gardeners, unfortunately, who are not aware of the general appearance of the common slug—a long, slimy body (it may be any colour) surmounted by a pair of retractile tentacles, and very similar to that of a snail without its shell. Nor need they be reminded of the damage done by this unpleasant animal in both flower and vegetable garden, for the semicircular bites which it takes out of lettuce and cabbage leaves are only too frequent a sight. But, as

H. Bastin

GARDENER'S FRIENDS

The small shell seen at the tail end of these specimens of *Testacella*, the snail-slug, should be a signal for the gardener to withhold his destroying hand, for this species, half-way between slug and snail, is a hearty consumer of garden pests.

will be seen, the majority of slugs are harmless in the garden, while one kind is of positive value.

The family tree of the humble and repulsive slug is an outstanding example of the immense labour that has been expended by naturalists upon the classification of the creatures of the earth and sea. Between the fishes and the insects in the evolutionary table there are the invertebrate animals, and of these one branch comprises the terrestrial *Mollusca;* the latter have been divided into many classes and sub-classes, of which one is the *Gastropoda*, and of this a further subdivision is the sub-order *Pulmonata*, a name that denotes that the animals therein possess organs analogous to human lungs. To this sub-order both snails and slugs belong, and these have been classified according to the largeness or smallness of the shells which they carry. The slug seemingly, it is true, has no shell, but here appearances belie the facts, for all the British species, at least, do possess some rudimentary shell hidden beneath the "mantle" or "shield," which protects the animal's vital organs—"lungs," heart and so on. Though naturalists are thus justified in dealing with snails and slugs together, it is more convenient to separate them, for the slugs in Britain alone number nineteen different species, each of which is divided into numerous sub-species, and the tangle of divisions and subdivisions that would be necessary to remember were the family taken as a whole can be readily imagined.

Let us begin with the *Testacella*, or snail-slug, an animal that holds an intermediate position between the true snails and the true slugs. Here the shell, a beautiful and delicate object, is formed in typical snail fashion and is visible externally at the hinder end of the mantle, like a little hat. The Testacella is the one variety which gardeners are advised to cultivate; indeed, so valuable are its services in consuming garden pests, including destructive slugs and its cousins, the snails, that specimens of Testacella were introduced into Australia some time ago for this very purpose.

Snail-Slugs of Harmless Habit

THREE kinds of Testacella may be found in Britain: one is a pale yellow animal, about three inches in length, whose mantle is nearly hidden by the shell; the second, yellow or brown, bears a similar shell; the third, which is about four inches long, is dark brown and carries a larger and rounder shell. All three kinds are found most commonly in the south-west. They feed only at night; often attack, as well as pests, small worms which they slowly engorge; and live to an age of five or six years.

If the protective value of the shell in the Testacella is small, in the other species of slug, those that are

FUNGUS FOR LUNCH

This brightly-hued specimen of the commonest slug, *Limax maximus*, is in the midst of an unusually harmless but significantly large meal. It has consumed a portion of the skin of the mushroom on which it is resting, working round from right to left.

M. U. Clarke

W. S. Berridge

VORACIOUS FEEDER

Posing gracefully on the underside of a leaf, the specimen seen above of *Limax agrestis*, the field slug, one of the most destructive varieties of slugs, is about to begin its damaging work. The shape of its hidden shell, with the breathing hole below, is clearly perceptible in this photograph.

further removed from the snail, it is smaller still, for in them the shell is mostly rudimentary, and often lies beneath the skin. Nearest to the Testacellidae in having perfectly formed but entirely hidden shells are the *Limacidae*; in them the shell lies beneath the mantle—a white and concave plate, bearing concentric lines of growth which are presumably relics of an original valve spirally coiled as in the common snail. This shell is larger in the embryonic stage than at maturity, but is retained throughout the slug's life; it is said to have been the shell used by the Romans as a lucky charm against disease. The skin on the mantles of the Limacidae is also finely marked with concentric lines, and this characteristic, together with the position of the respiratory opening, or breathing hole, which in the Limacidae is situated on the edge of the mantle slightly behind the centre of the slug, affords a reliable identification mark.

Like the Testacellidae, the Limacidae are of three kinds. The most interesting, *Limax*, the grey slug, is probably the most adaptable and tenacious of life of all the slugs. Deriving from the most ancient times, as its fossil remains prove, it moves quickly and with decision and has a keen olfactory sense; it is a "slug of character," and naturalists have paid tribute to its perspicacity in detecting changes of food given to it in captivity and to its determination in reaching its desired destination however great the obstacles that are put in its way.

TAKEN as a whole, the Limacidae well repay investigation; the wide variation in habit and habitat and the startling differences of colouring in its various members are remarkable. Some species, for instance, live and feed below ground, leaving their burrows only in wet weather; while of the others, living on the surface, some are carnivorous and some confine themselves to a diet of fungi. The latter are able to consume even the deadly agaric without hurt. One species is cannibalistic, and will eat slugs of other species and even make a meal off its own brethren.

The colours of the Limacidae range from black to white, grey, brown, ochre and crimson; their markings also vary widely, some showing simple stripes and others elaborate patterns of considerable beauty. One species, for instance, bears patches of black superimposed on a pinkish-grey ground colour; this is the type frequently found in cellars, greenhouses and gardens, whence its name *Limax maximus cellaria*. Another, called *Limax flavus*, takes its name—*flavus* being the Latin for yellow—from a yellow-olive slime that it excretes, against which its tentacles stand out a bright blue. The reason for these and other colours has been a subject of close study, and it has been noted that the colours are more varied in the south and west than elsewhere. Mild climates, it seems, produce brighter and stronger colours, and in colder latitudes the slugs are duller and less varied. The theory based on these observations is that certain atmospheric conditions, more prevalent in the south-west, act, together with the main blood sinuses, to produce an accumulation of pigment. Thus certain sub-species, given separate names by naturalists, may in reality be no more than varieties of the normal type whose colours have been varied by changes in the weather during growth. An example of the effect of climate is seen in the *Limax cinereo niger*, which in southern Europe is the most brilliantly coloured of all slugs, but in England is black only, with very dark markings.

REMOVED still further from the snail is the third class of British slugs—the *Arionidae*. In them the shell is nothing more than a number of coagulated grains of calcareous pulp, lying in the space behind the mantle called the "shell-sac." The grains are soft at first, but harden when exposed to the air, the degree of hardening varying with the age of the slug. The Arionidae may be distinguished from the Limacidae by their

M. C. Clarke

YELLOW AND BLUE

A bright yellowish slime is exuded by this olive-yellow slug, *Limax flavus*, and its tentacles are a clear blue; such light colours in slugs are rarer in Britain than abroad. The contours of this specimen are particularly generous, and its mottled "shield" and breathing hole unusually large.

rounder and stouter body, the folds of the skin being raised into coarse elevations and ridges, and by their indented and warty mantle. The breathing hole is nearer the neck than in the Limacidae and is on the right edge of the mantle. The Arion comes out only at night, hiding in the daytime in holes in the ground, under fallen trees and in old tree-stumps. It is a less interesting slug to study than the Limax, more easily and quickly succumbs to slight injury, and when approached usually rolls itself into a tight ball, rocking slowly backwards and forwards. One of the commonest species of this group is *Arion ater*, or the black slug, which may measure from two to five inches, and is found in cold and wet districts. Warmer and drier climates produce a red Arion, whose red pigment is affected by wet weather. Another species is the gardeners' enemy, *Arion hortensis*, a small slug measuring about one and a half inches, with an abnormally tough skin which makes it hard to kill. One of its sub-species is the particular pest of strawberry beds; but one weakness in its character can be utilized by the gardener to destroy it—it is partial to beer, and can be killed or at least incapacitated by intoxication with a few drops of this liquid.

M. U. Clarke

LIMAX'S BABIES

The slug—a hermaphrodite—lays its eggs in springtime on a portion of decaying wood, such as is shown above detached from a dead log. From these little jelly-like balls emerge later the baby slugs, of which one (but a day old) can be seen in this photograph.

Slugs are hermaphrodite; their reproductive organs are similar to those of the snails, and mating takes place in much the same way. The slug, however, has no calcareous darts for enticing its mate. The eggs, consisting of little balls of jelly, are laid in the spring or summer in moist places, either under the ground or in the decaying wood of dead trees. The baby slugs, which hatch out after about forty days, are somewhat lighter in colour than their parents; within a year they grow to normal size and take on the pigmentation characteristic of their species or sub-species.

J. J. Ward

ON ITS ROCKY BED

In the *Arion ater*, or black slug, a dormant example of which is photographed above, the shell has degenerated to a few calcareous granules, for so tough and unpalatable is its skin that this variety has no need to protect its vitals from birds.

W. S. Berridge

SLIMY GLUTTON

This well-developed specimen of black slug is rearing its head high. With its sleek neck and ridged back, it has a well-fed and prosperous appearance that is enough to aggravate any gardener on whose plants it has recently gorged itself.

Most slugs spend their lives on the ground, but in such species as the tree slugs the animals climb up the trunks of the trees and spend practically their entire lives among the branches. In some species they are able to drop from branch to branch like spiders, suspending themselves on threads of mucus secreted from the pores of the skin and controlled by means of the foot. These tree slugs are a distinct group of the Limacidae, and are slender in form, often having very beautiful colouring in red, yellow and grey. Another group comprises the field slugs, extremely destructive animals that are betrayed by their milky white slime and the white ring round the breathing hole. These change their colours from a pale cream in the spring to rich, dark brown in the autumn. The gardener's other chief enemy among the slugs, the keeled slug, is grey, tinged with yellow; the amber "keel," a dorsal ridge found in all slugs, is paler than the rest of the body, and is most prominent on the back, fading by degrees towards the tail.

Darwin's Story of the Two Slugs

In one of his books, Darwin has a story that illustrates what may be called the mental equipment of the slug. He observed two which had made their way into a barren and foodless garden; the more adventurous and resourceful left its companion, crossed a wall and discovered beyond a slug paradise. Instead of contentedly settling down to a greedy and solitary enjoyment of the feast, it turned back, once more traversed the wall and returned with its timorous companion to share the good fortune. This procedure would seem to argue in the slug some kind of memory, as well as an almost human desire to share good luck.

ORCHIDS THAT NEED NO HOTHOUSE CLIME

SOME of the forty or so orchids found in a wild state in Britain are described in earlier chapters in this series (pages 174 and 268). Now in the chapter below we tell of the so-called insect orchids—orchids, that is, which resemble to a greater or lesser degree the creatures (not only insects) after which they are named. As will be seen from the photographs accompanying the text, the supposed resemblance is not always apparent, but there can be no doubt about the almost exotic loveliness of these flowers of the wild

WHILE the majority of British orchids suffer by comparison with the exotic varieties that are found wild in the tropics or are grown at great expense in the hothouses of the rich, Britain does possess half a dozen or more species of orchis that can well compare for beauty and strangeness with the most gorgeous of tropical flowers. The bee, the spider, the fly and the butterfly orchids, for instance, are well worthy of study, and are, moreover, fairly widely distributed throughout the British Isles.

Found wherever there is chalk or limestone country, from Durham and Lancashire southwards, the bee orchis is one of our most attractive flowers. The features that characterize the orchid family have already been outlined in page 175, and it will be remembered that the sepals and petals of the normal flower are replaced in most forms by a perianth of six rather indeterminate parts.

RARE SPIDER ORCHIS

Below is seen a typical plant of the early spider orchis, while the small photograph to the right shows, enlarged about twice, a single flower of the same. Notice the short stem and few flowers, and the markings on the velvety lip, which help to distinguish this from the bee orchis in the opposite page.

A. W. Dennis

In the case of the bee orchis, however, we can separate petals and sepals with some degree of certainty.

In the bee orchis flower the first object to strike us is the lip, and it is to this that the species owes its name, for it is held to resemble a large, velvet-backed bumble-bee. Although to many the resemblance will seem rather fanciful, it is more apparent than is the case among many other flowers that have gained their names from supposed resemblances to insects or other creatures. This lip is deep brown, and is marked with orange or yellow in a symmetrical pattern. Its sides are curved upwards and slightly inwards (their form adding to the likeness by having the appearance of the upper parts of the bee's hind legs), while its extremity is elongated and curved downwards. The other petals are represented by two short, peg-like bodies that stand erect from the top of the flower, the long "column" being here a hood-like organ, which, like the petals, is green. This colour scheme is admirably set off by the sepals, which are bright pink or lilac, and project one on either side and one above the rest of the flower. Beneath each flower—there are several, sometimes as many as a dozen, on a single stem—there is a large, leaf-like bract.

M. H. Crawford

The true leaves of the bee orchis may be found quite early in the year, long before there is any sign of the flower shoot. They are a bluish green and unspotted, and are thus more difficult to discover than those of such species as the early purple and spotted orchids, whose leaves are covered with purplish spots. Each bee orchis plant sends up a single stem, and the flowers open only one or two at a time; thus there may be buds, open flowers and quite large ovaries on the stem at the same time. A noticeable feature of the genus *Ophrys*, to which the bee orchis belongs, is that the ovary is not twisted as in the other types described earlier.

SIMILAR in many ways to the bee orchis, but much rarer —it is confined to a few counties southwards from Northampton—is the spider orchis, also called the early spider orchis. This is a smaller, stouter plant than the bee orchis, its stems being usually considerably shorter—a feature probably accounted for by the exposed situations in

which it grows, for it is essentially a plant of the open downlands. In this species the sepals are green and the lip is marked differently from that of the other, and is perhaps a little more hairy. The " tail," a protuberance of the lip that is curved under the rest in the bee orchis, is absent in the spider variety. The latter also flowers rather earlier than the former ; its blooms are always to be found in spring, whereas the bee orchis flowers are rarely out before June. The late spider orchis is found almost solely in Kent and Surrey. It differs from the typical bee orchis in having the tail of the lip extended straight outwards, while the lip is markedly longer than the sepals, but it is considered by many to be little more than a variety of the bee orchis.

A third orchid that bears an " insect " name—the fly orchis—is also confined to chalk and limestone districts, but is not a common plant, although its range extends from Durham to Kent, wherever the soil and other conditions are suitable. Striking as the likeness of the bee and spider orchids may be to those creatures whose names they bear, there is no doubt that in the case of the fly orchis the resemblance is even more remarkable. The lip of the flower is elongated and is cut into three lobes, of which the central one is by far the largest, and is cut at its lower end, as if a wedge-shaped portion had been removed. At the point where it joins with the other two lobes there is a band of blue. The colour of the rest of the lip is bright red-brown, and this, with the blue band, makes the whole flower extremely conspicuous. The upper two petals in the fly orchis are thin and considerably longer than in the other species. The yellow-green sepals are arranged as in the bee orchis, their colour acting as an admirable foil to the brown of the lip. The light green stems harmonize well with the background of fine grasses against which this plant usually grows, so that the flower's likeness to a great, brilliantly-coloured fly sitting on the stem is heightened.

C. F. Metcalfe

Charms of the Great Butterfly Orchis

As different as can be imagined from the three species already described, but at the same time possessing the strange form that at once betrays its membership of the same order, the great butterfly orchis is one of the loveliest of our wild flowers. It has a delicacy that is found in few British orchids, and a scent whose sweetness is, perhaps, unrivalled in the whole group, and, its situation being usually the middle of some cool, dark wood, it comes as a lovely surprise to the eye. The effect on us of seeing for the first time this beautiful flower is almost comparable in intensity with that wrought by the most gorgeous of its tropical cousins ; slim, straight, brilliant against a carpet of dead, brown leaves or yellow, dried grasses, it delights our senses with both its scent and its appearance. Especially is this true in the evening, when the scent is at its best and the flowers are most striking.

The flowers are of the usual orchid type, having a perianth that is divided into three sepaloid and three petaloid portions. In the butterfly orchis all the parts are white or greenish-white. The lip petal is long and narrow, thus differing from that of all the other orchids so far described, and may be about half an inch in length. The two upper petals are small and narrow, and are usually curved inwards over the entrance to the flower ; their outer surfaces are greenish. In the centre of the flower the pollinia appear as yellow points, showing up brightly against the white of the throat. There is a very long, thin spur, twice as long as the ovary and pedicel, and the ovary itself is curved in the same way as in the early purple orchis described in page 175.

A number of these flowers are borne on a long, straight stem, which arises direct from the leaves. The latter are usually only two in number ; they are ovate and

'BUMBLE' OF THE ORCHIDS

Receiving its name from its resemblance to a large, furry bumble-bee, the bee orchis has pink " wings " and a brown body. In the small picture (left) of a single flower, one of the pollinia may be seen hanging forward on the left-hand side above the lip.

E. J. Bedford

A. W. Dennis

FLY' VARIATIONS

The fly orchis is a variable plant, as the range of specimens shown above demonstrates. The picture at the top of the right-hand column shows how the pollinia, two tiny white bodies above the lip (left), are removed when fertilization has taken place (right). These two flowers are enlarged about three times.

pointed, having marked parallel venation. Occasionally plants of this species are found in which there are more than two leaves, but this is uncommon. Beneath each flower there is a leafy bract of the type found in a similar situation in all the orchids.

THE great butterfly orchis is one of several very closely related species, of which the lesser butterfly orchis is another. This is very similar to its "great" relative, but is distinguished by its narrower lateral sepals and straighter, more slender spur. It flowers from the end of May until August, whereas the great butterfly orchis is rarely found in bloom before the middle of June. Both these plants are members of the genus *Habenaria* (Lat. *habena*, a strap or thong), so called on account of the shape of the lip.

A third member of this genus is the orchid known as the small white habenaria, alternative names of local application being small white butterfly orchis, least butterfly orchis, and least habenaria. This plant is rare, but may be found in all parts of the British Isles. It is a plant of the hilly pastures, whereas the other two species, though they will grow

well in the open, and are often found in heathy places, are more fond of a woodland habitat. The flowers, which are white, are only one-sixth of an inch across, the tiny lip being three-lobed and the sepals forming a spur. Growing close to the stem, these flowers are more numerous than in either of the other two "butterfly" species. The roots show a further difference, for whereas in the great and lesser butterfly orchids they consist of

M. H. Crawford

SWEET-SMELLING CLUSTERS

In many respects similar to the orchids illustrated in pages 268-270, the lovely flower seen in this photograph, the fragrant orchis, is remarkable for its fine scent. The flowers have a very long spur, a three-lobed lip, and wide-spreading sepals, and in colour are pale purplish red.

a pair of tubers, as is usual in orchids, in this plant they are composed of a mass of small fibrous bodies.

Another member of the genus *Habenaria*, the frog orchis, is one of the many British plants that have acquired a reputation for rarity which is really not merited. It is similar to the small white habenaria in so far as the form of the flowers is concerned. They are, however, green, striped with dark reddish, and are about three times as large. The more numerous leaves are narrower than in the butterfly orchids, and the whole plant is very much smaller, being rarely more than eight inches in height, as opposed to their eighteen inches or so. The frog orchis is not a raré plant, although local; it must be looked for on pastures in hilly country, but is not found in Cornwall.

Fragrant by Name and Nature

One more species of *Habenaria* is fairly widely distributed in the British Isles—the fragrant orchis, whose name alone is a sufficient description, so strong and beautiful is its scent. This flower would appear superficially to have no resemblance to the other members of the genus. Its colour is reddish-purple, the lip being lobed, and there is a long, slender spur twice the length of the ovary. The flowers, which are very numerous, grow in a dense, cylindrical spike, and the whole plant is more reminiscent of a member of the true genus *Orchis*, such as those described in pages 268-270, than of a *Habenaria*. By many botanists, indeed, it is classed in a separate genus of its own, under the name of *Gymnadenia*

M. H. Crawford

HUMAN LIKENESS?

The man orchis, so-called from the fancied resemblance of its flowers to a series of tiny, green men, is one of the most local of all our plants. Confined to certain districts on the chalk hills, it is never conspicuous, for both its flowers and leaves are green, and tone well with the grassy background.

(Gr. *gymnos*, naked; *aden*, gland). It may be found in dry, hilly pastures or heaths all over the British Isles, but here again we have a plant that is not as widely known as we might infer from its distribution.

One other species of orchid is sometimes placed in the genus *Habenaria*; this is the exceedingly rare entire habenaria. The leaves of this plant are spotted, and its small reddish flowers are in a dense spike, each having

E. J. Bedford

'GREAT' AND 'LEAST'

Above are two sprays of the fine great butterfly orchis. Notice its white, long-spurred flowers with their spreading "wings" and long lip. In sharp contrast is the least butterfly orchis (right), one of whose several other names is least habenaria. Confined to dry heaths and hills, it is widely though sparsely distributed.

R. M. Adam

E. W. Tattersall

NOT REALLY RARE

Yet another of those fascinating orchids that owe their names to an animal or insect resemblance, the frog orchis is not a very noticeable plant, for the colours of its flowers are dull green with reddish stripes. Its reputation for rarity is due more to insignificance than to any real scarceness.

an almost globular spur. It is confined to Mayo and Galway, and even in these localities is not easy to find.

Besides the members of the two genera *Ophrys* and *Habenaria*, we have several other orchids that are named from their fancied resemblances to some animal form or other. Amongst these mention must be made of the man orchis, a very local plant confined to the chalk hills of Yorkshire, the east coast and the downs of our southern counties. This is one of the rare plants that may be found on the slopes of Box Hill in Surrey.

The resemblance to the form of a man is perhaps no greater than that already noticed in the twayblade, described and pictured in pages 269-270. The two-lobed lip is yellow and is about half an inch long, the diameter of the flower being between half and three-quarters of an inch. The three sepals and the two upper petals form a curious little hood over the top of the flower. The flowers are borne in a long, loose spike, from six inches to one foot in height. The leaves are lanceolate and rather long, often having parallel sides. To find this plant we must look in hilly, dry pastures where there is a chalk soil.

SMALLEST and most insignificant of all our orchids, the bog orchis is not really very rare, being found in suitable country all over the British Isles. Its small size, however, and its dull flowers make it very difficult to find, even when we know that it grows in an exact locality, so that it is not surprising that it has the reputation of being a very rare plant indeed. From one to four inches in height, the stems bear a large number of tiny flowers, each of which is less than a quarter of an inch in diameter. These flowers have three small ovate sepals, and the two lateral petals are narrow and parallel-sided. The lip petal is concave, and the colour of the entire flower is a dull green. The stem is angled in its upper part, but the base is swollen.

In addition to the orchids described in this and earlier chapters, there are a number of further species, most of which are very rare, while at least one is parasitic. These species are described in later chapters.

Revealers of Nature. 16

SIR JOSEPH HOOKER

IF the London Zoo is a paradise for animal-lovers and students of zoology, the choicest site of study for botanists in London must be Kew Gardens. But few realize that they owe practically entirely the continued existence of the Gardens to Sir Joseph Hooker (1817–1911), who was Director of Kew from 1865 to 1885. For it was he who, backed by public opinion, saved Kew from becoming a mere recreation ground when it was transferred from the control of the Forestry Department to that of the Office of Works. But Hooker was more than the saviour of Kew; he was the most distinguished botanist of the age that produced Darwin, Lyell and Huxley, and he was an explorer who was the first European to visit Eastern Nepal and set foot in the Tagharat Pass of the Great Atlas Mountains of Morocco. Scarcely any part of the world was unvisited by Hooker, whose most important works include "Flora Antarctica," "New Zealand Flora," "Flora of British India," "Himalayan Journals" and "Flora of Tasmania"—books whose titles alone indicate the wide range of his travels and studies—as well as a classic "Student's Flora of the British Isles."

Hooker's principal achievement was to lay the foundations of the study of the geographical distribution of species, and the importance of both this subject and his work upon it may be gathered from the words of Darwin to Hooker: "I shall live to see you the first authority in Europe on that grand subject, that almost keystone of the laws of creation, geographical distribution." Hooker's, Darwin's and Lyell's work was intimately interconnected; inspired by Lyell's discoveries, Darwin looked for the origin of species, Hooker for their method of distribution. The ideas of "evolution" and "natural selection" came to them all about the same time, as they came to A. R. Wallace, then living on the other side of the world; and it was Hooker who took the most important part in persuading Darwin to announce his theory to the Linnean Society on that epoch-making day, July 1, 1858. Moreover, Hooker, in one of his books, published in August, 1859, first stated in print the theory which Darwin did not give to the world as "The Origin of Species") until November of the same year.

Among Hooker's many other notable achievements were the theory that the cedar-species of Lebanon, of Algeria and of India were descended from one common form which once flourished at a much lower level and from which they later spread upwards and outwards as a result of climatic changes; his insistence that botanical species were not separately created but that there was some rational explanation of their distribution in widely separated countries; his famous and monumental work, *Genera Plantarum*, undertaken with his friend George Bentham, which was based throughout on their own knowledge of their subject and not at all on previous works of the same kind; and, possibly most interesting of all to the ordinary Nature-lover, his introduction to Kew of the lovely Sikkim rhododendron.

The value of Hooker's work did not go unrecognized. In 1873, at the age of 56, he became president of the Royal Society; in 1877 he was knighted; in 1907, on his ninetieth birthday, he was presented by King Edward with the Order of Merit; he also held the Prussian order *pour le mérite* and received gold medals from scientific societies all over the globe. He died on December 10, 1911, actively working to the end

One of Sir Joseph's last great public appearances had been at the 50th anniversary of Darwin's announcement of his theory of the origin of species to the Linnean Society. Darwin's prophecy had come true; Hooker *was* "the first authority" on his subject—first both in time and in the importance of his conclusions; and if, as Darwin claimed, the study of geographical distribution is the keystone of the laws of creation, Hooker is the prime architect of the modern science of Natural History.

SWANS AND TERNS IN THEIR WATERY HAUNTS

On the Thames and on the lakes of many of our public parks, the stately swan is a frequent and much admired spectacle. Though often encountered, however, this bird is rarely studied, and many of the details of its life given below will be fresh to most readers. Still more is this true of the far less common tern, the second bird discussed in the chapter

So familiar to almost all of us are the swans that frequent our rivers and lakes and ornamental waters that it probably occurs to but few people to wonder where they came from, whether they are wild or tame, and whether they are all of the same species or not. Actually, almost all the swans that we are likely to see in the ordinary course of events are members of the same species, the mute swan. Two other species, both wild, are to be found round our coasts as winter visitors, but the mute can hardly be called a wild bird, for it has existed so long in a state of more or less complete domesticity that there can be no dividing line between individuals that are completely wild and those that have owed their existence for many generations to the protection of Man.

The two wild species, namely, the whooper swan and Bewick's swan, both breed in northern Europe and Asia, Bewick's swan being a more decidedly Arctic species than the former. In both these birds the beak is black, with a yellow patch at the base; in the whooper this patch extends down to the nostrils, where it ends in a point, while in Bewick's swan it is smaller, being rounded and not extending so far. A better way of distinguishing the two birds is by their size, the whooper being about 5 feet from beak to tail, while Bewick's swan is only 50 inches. The whooper is the same size as the mute swan, which may be distinguished by its orange bill, with its tubercle, or knob, known as the "berry," at the base of the upper mandible.

The whooper may be found around our coasts from November to about June, though that is rather late for birds to remain under normal conditions; Bewick's swan, on the other hand, seldom stays longer than for the three winter months. The latter bird is fond of the company of its fellows, and large flocks are not infrequently found in the lochs and inlets of brackish water which form its chief haunts in this country. Both these species may be further distinguished from the mute swan by the fact that they do not swim with the wings

CYGNET BROOD

These baby swans, though very young, show remarkable liveliness when compared with the young of some of the other birds whose pictures appear in other pages. They are, in fact, sitting up and taking notice in a way that evokes the evident pride of their mother, standing on guard over the nest.

P. Webster

J. H. Stone

FAMILY SUNBATH

Birds are as appreciative of the sun as human beings, and these cygnets, sitting on the shelving beach with their mother, are passing the time in a lazy sunbath. Their soft down contrasts strongly with the broad, snow-white feathers of the parent bird—plumage they will not acquire for some months.

raised in that glorious, graceful arch that we so often see in the latter bird, but always keep them folded flat on the back. The gracefully curved neck is typical also of the mute swan; perhaps, in the other two birds, shyness may cause them to keep their necks straight as they swim about, enabling them to see danger farther off. Even when they bend the neck to feed, the curve is more the angular one of a goose than the lovely bend adopted by the mute swan.

Both the whooper swan and Bewick's swan may be found, at one time or another, in company with the mute swan, when hard weather has forced the birds inland in winter, but, as has been mentioned above, the swan that we see on the ornamental lake of the public park or on the quiet waters of some broad river may be taken for granted to be a mute. Its appearance, completely white except for the beak, which has already been described, is too familiar to need further description, although it may be noted that the young birds, which are known as cygnets, are not white, but greyish-black for the first year or more. At this early stage the tubercle is absent from the beak, which is black.

The mute swan is the only species of the bird that nests in the British Isles. A mass of rushes or other water weeds are the materials of the swan's nest, which is usually situated on an island or in the depths of a reed bed, though it may be quite exposed; it is lined with the bird's down. The eggs, greenish-white and numbering anything from five to a dozen, are just over $4\frac{1}{4}$ inches in length. The parent birds show remarkable ferocity in defending the nest, and the "cob," as the male bird is called—the female being a "pen"—will attack intruders without much provocation. By way of warning to those who may desire to add a swan's egg to their collection, it may be mentioned that the blow of the beak or wing of an enraged swan may break a bone, and will at any rate be something not easily forgotten. When advancing towards an enemy the cob forces himself forwards with wings and feet simultaneously, so that he proceeds in a series of rushes, with wings raised and head held right back between them—a terrifying sight.

In the large colonies, known as swanneries, that exist in various parts of the country ample opportunity is afforded for studying these birds. The male occasionally monopolizes the duties of incubation, refusing

SO UNDIGNIFIED!

Diving for food, in the manner adopted also by ducks, the upper swan in this picture provides an amusing sight as it works with its feet to keep itself from tipping back to the surface. The bird in the foreground appears to have turned away as if to disown so undignified a companion.

O. Guggenheim

SWAN PROCESSION

Winding in and out of the grasses that spring from the bed of the rushy stream, the swan family makes for fresh pools and reaches. The cygnets are keeping close to the parent birds, but in a few days they will be quite capable of looking after themselves.

E. J. Hosking

CONTEMPLATIVE BEAUTY

Sailing along the untroubled surface of the river, the swan is one of the loveliest of all creatures, its snowy wings arched over its back and its neck in a characteristically graceful curve. This individual seems to be contemplating its own reflection mirrored in the surface of the limpid stream.

to allow his spouse near the nest until after the cygnets have put in an appearance. The idea that the swan is mute and finds its voice only when it is on the point of death seems to be due purely to lack of observation on the part of early writers. The cob is said to have a trumpeting note when defying intruders at the nest, and there is a low " song " note that is uttered during the breeding season. When annoyed, and when on the defensive, the bird will also utter an alarming hiss.

Some of the swanneries in the British Isles have been in existence for several centuries, perhaps the most famous being that at Abbotsbury, in Dorset. The naturalist who visits this swannery is inevitably attracted to another great avian colony near by, namely, the ternery. Terns—or, as they are sometimes called, sea swallows, though they are not relatives of the true swallow—are among the most beautiful of all our birds, and, though they tend to be restricted to certain parts of the coast, are worth travelling some distance to see.

Five species of terns nest in colonies in the British Isles, and of them the most frequently encountered is the common tern. It nests in suitable situations all round our shores, and is one of those birds that the naturalist will readily be able to recognize, or at least to distinguish from the gulls. The long, narrow wings and long, forked and pointed tail—features which have earned the bird the name of sea swallow—make a tern unmistakable among the gulls of the coasts, while its small size is also noticeable. To distinguish the various species of terns from each other, however, is less easy.

The common tern is a grey-backed bird, with grey wings; it has a black cap to its head, a white tail, and whitish underparts that vary from blue-grey in summer to pure white in winter. This bird can be distinguished from the Arctic tern, a much scarcer species, only by the fact that in the latter bird the cheeks and throat are pale grey, and there is discernible no sign of the bluish tinge that sometimes suffuses the common tern's underparts. The bill is another important index, for in the common tern it is red, with a black tip, while in the Arctic tern it is usually entirely red. On the wing the two species are practically indistinguishable. The Arctic tern is perhaps the most widely distributed of all birds, being found in both the Arctic and Antarctic; in England it breeds in a few places only, being commoner as one goes northwards.

The Sandwich tern may be recognized by its size—which is noticeably greater than that of both the common and the Arctic terns—and by its shorter tail, which is less forked than in the other species. Its whole

AWAITING ADMIRATION

Here we see the swan posed to show off its distinguishing features. Note the " berry," as the knob at the base of the bill is called, and the short, strong legs with the very broadly webbed feet. The tail points off the body in graceful and valuable streamlined form

E. C. Le Grice

build, too, is heavier. It is a widely distributed tern, nesting in several large colonies, notably at Walney and Ravenglass, and in the Farne Islands, where, in fact, all the terns find conditions to their liking. Another species, the roseate tern, is easily distinguished by its pale, delicate pinkish underparts, by its bill, which is almost entirely black, or at least sooty, and by its shorter wings and very much longer tail streamers. Finally, there is the little tern, a bird whose size marks it out from all others that are likely to be seen at the same time. The length of the wing is only six and a quarter inches, and that of the whole bird ten inches. The black tern used to nest freely on the east coast, in the time of its abundance being also known as the "carr-swallow," but as a breeding species it is now extinct, although it is still a passage migrant. In this tern black replaces pale greys, and the tail is short, so that in length the bird is less than the little tern, although its wing is almost two inches longer.

Things Seen in a Ternery

A visit to a ternery is one of the most remarkable and exciting experiences the naturalist in these islands can have. The colonies may be on the shore, on sand or shingle, among the rough ground behind the foreshore, or even on bare rock. There may be no nests at all, merely hollows scooped in the ground, or there may be quite large nests of grasses or seaweed. Materials of all sorts are used, and often the eggs are surrounded by a ring of broken sea-shells, added after incubation has begun. Each pair of birds seems to have its own

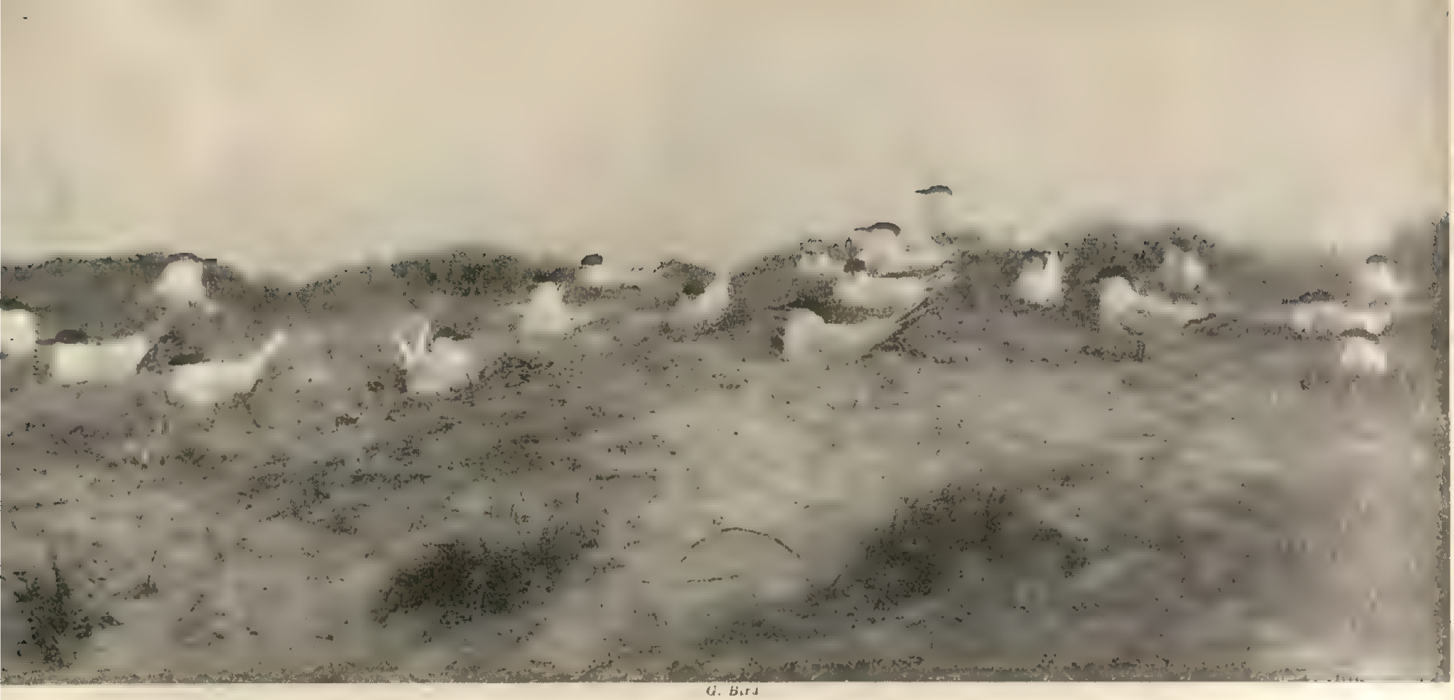
H. ilford: Crook

GRACEFUL LANDING

Few birds are so beautiful as the terns, and this common tern (above), snapped just as it alights on the sand, shows to the full the wonderful wings and the long, pointed tail that have earned for them the name of sea swallows. On the left a female tern on the nest is calling to her mate, flying overhead.

preferences, but one hardly ever finds nests in which materials are mixed. When the female is sitting on the eggs the cock bird feeds her, thus setting an example which many other avian husbands fail to follow. The gift of a fish as an offering forms an important part of the nuptial display of the tern, but this gift is delivered only on acceptance of the suitor. Failing this, he eats it himself.

The courage shown by the birds in attacking an intruder is remarkable. They swoop down repeatedly, with harsh cries of anger and alarm, as one walks among the nests, and dive fearlessly at the visitor, often striking at his head and face. The young of other birds that wander into the precincts of the colony are often killed, their skulls battered in by the blows of the angry birds,



G. Bird

COMMUNITY NESTING

Terns are sociable birds, and their nests are built on, or scraped from, the sand, within easy reach of each other. This picture of a large colony of Sandwich terns shows a typical scene in the ternery during the nesting season. The black heads and white bodies of the birds make a fine contrast with the brown of the dunes and the dull green of the coarse grass.

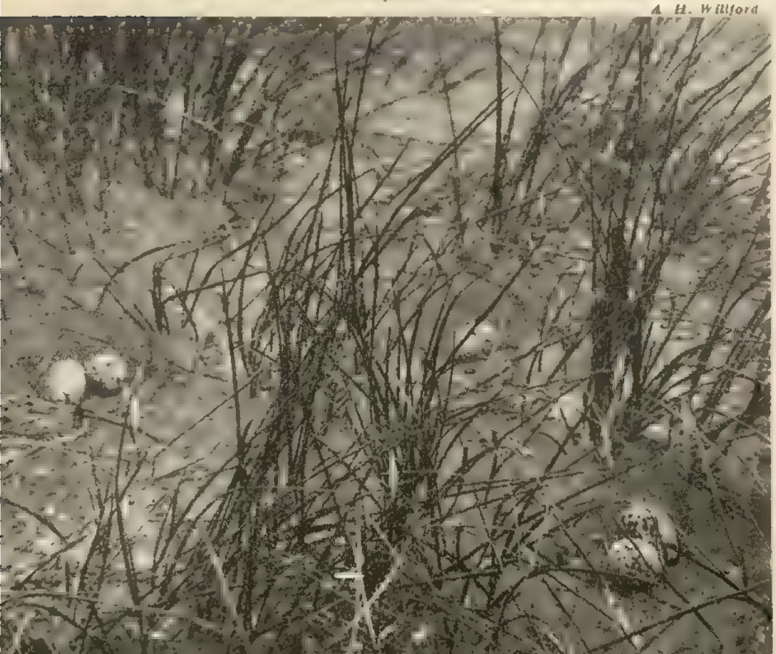
and innocent passers-by overhead are mobbed and driven away. Once one has become accustomed to the tumult and to the dazzling brilliance of the flashing wings the life of the community can be watched without much trouble, one's only care being for the occasional angry dive of an especially nervous parent.

The terns lay two or three eggs, which are all of the same type, although the eggs of individual birds vary greatly in colour and in the nature of the markings. The ground may be greenish, yellowish or brownish, with brown, black or grey markings, in the form of spots and blotches or even large patches of darker colour. Owing to the open nature of the nests, which are always on the ground, the eggs and young nestlings are especially liable to the attacks of rats, stoats and weasels, and of several hundred eggs in a large ternery only a few dozen birds may survive the fledgeling stage. The down of these nestlings, which makes them extremely hard to see if they squat close to the ground, is brownish, greyish or pale buff, with dark markings. As they grow up they retain much of the brown coloration, and even when they have reached their full size the crown is speckled with brownish and the back is grey and buff. These particulars apply to the common tern, but the differences in the other species are not very marked. The terns lay in May or June, a few weeks after their arrival in this country—for even the common tern is a summer visitor—and the roseate tern about a month later.

HOMES IN THE SAND

Sand-dunes are among the favourite sites for the nesting terns, as this photograph, and the one above, both show. Here we see the eggs—those of Sandwich terns—laid in shallow hollows scooped from the sand. Only a clump of marram grass separates each nest from the next, but terns are quite indifferent to privacy in the arrangements of their home life.

A. H. Willford



M. H. Crawford

HATCHED AND UNHATCHED

Only very recently emerged from the egg, this little tern has the same markings as those which help to disguise the as yet unhatched egg in the same "nest." Although helpless, it can reasonably rely on its protective colouring; indeed, the nest is so shallow that this is its sole protection.

WILLOW SHEEN

Here is pictured in its summer radiance a particularly fine specimen of the crack willow. By good hap it has escaped being pollarded, and so it is far more of a tree than the maimed specimens usually found congregating along a stream bank.

British Museum (Natural History)

BATS THAT PASS IN THE GLOAMING

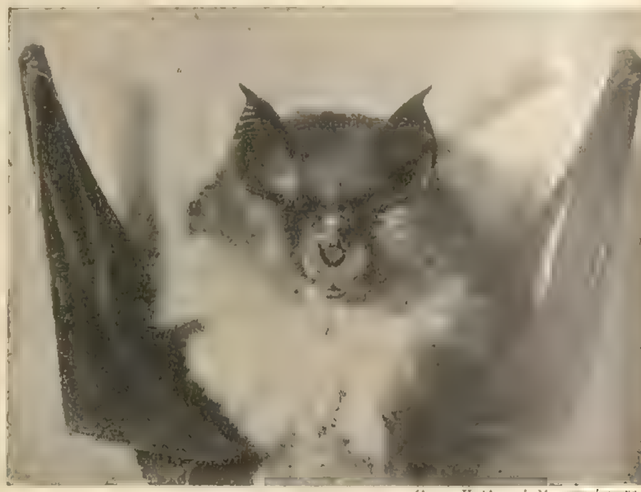
When daylight fades into dusk, the bats emerge from their sleeping quarters in eaves and caves, belfries and steeples and hollow trees, and flit hither and thither in their search for food. Crepuscular and nocturnal creatures as they are, it is not to be wondered that they are among the least-known of our mammals, and though (as will be seen from what is said in the chapter below) the information available is more extensive than is commonly realized, bats provide a fertile field for future observation

Apart from the birds, the bats are the only surviving vertebrate animals which are still supplied with organs of flight, and but for this fact naturalists would certainly have included them in the order *Insectivora*, together with the mole, the hedgehog and the shrews. But the adaptation of the bats for flying marks them off so sharply from all other animals that it has been agreed to set them apart in a special order—*Chiroptera*, or "wing-handed" animals. In Britain there are twelve distinct species of bat; some of these are fairly common, but the majority are found only rarely and in very limited localities. However, the rambler may encounter at some time or another the common bat or pipistrelle, the long-eared bat, the greater and lesser horseshoe bats, the whiskered bat, the serotine, the noctule, Daubenton's or the water bat, Natterer's bat, and the barbastelle.

The first of these, the pipistrelle, is, in a general sense, familiar to everyone, for on summer evenings it may be seen flying round and round, even in the crowded streets of the cities. Its distribution in Britain extends from the south to as far north as the Hebrides, and it occurs all over Ireland. It may be distinguished partly by its small size—it measures only about three inches in length—and also by the rather small, triangular ears with their blunt tips. The tail is a little over an inch long, and the wing-span eight to nine inches. The silky fur is reddish-brown on the upper parts and slightly paler beneath. The wing membrane and the ears are black.

Perhaps the easiest of all species to recognize, the long-eared bat possesses a very distinctive character in its huge ears, which are almost as long as the bat's forearm and somewhat longer than its body. It is to be found in all parts of the British Isles, but is rarer in the north than elsewhere. The head, the body and the tail together measure about three inches. The expanse of the wings in flight is about ten inches.

The horseshoe bats and the whiskered bat are distinguished—the former by the absence of ear *tragi*, or lobes, and the latter by its delicate form and hairy ears.



G. S. Hett and M. ... Lowe

HORSESHOE VISAGE

This close-up of the lesser horseshoe bat shows the strange appearance of its face, to which is attributable the name of "horseshoe." This bat is about 3 inches long, measuring from nose-tip to tail-tip, and may be found in caves and other sheltered places in the south and west of England.

M. Blackmore

WINGS OUTSPREAD

In this photograph of a young lesser horseshoe bat the details of the wing structure may be clearly seen. It will be noticed that the wing itself is composed of a membrane and that this membrane is stretched over the bones of the arm and the fingers and thumb.

The serotine and the noctule are two of our largest bats, and, as is found with so many of these species, identification may be effected by an examination of the ears. The serotine has oval-triangular tragi with rounded tips, while the noctule's ears are very short and bow-shaped, being broader above than they are below. The head and body of the serotine are about three inches long, and the tail is nearly the same length. The wing expanse averages fourteen inches, while in the noctule (the largest British bat) it is usually half an inch or an inch more.

Daubenton's bat was once thought to be very rare, but has since been found to have a wide distribution, having formerly been confused with the pipistrelle, which it resembles closely in size. Natterer's bat is somewhat similar to the whiskered bat, but is a little

larger, and has a much greater wing-spread in proportion to its size. The barbastelle is found chiefly in the south of England. It has a wing-spread of a little more than ten inches and shares with the long-eared bat the distinction of having its ears connected where they join the head.

In addition to these ten species there are two more bats, which are, however, unlikely to be seen by the rambler—Bechstein's bat and Leisler's bat. The former is restricted to the south of England and is the rarest of British bats; most of our knowledge about it has been gained from the Continent, where it is more plentiful. Leisler's bat is also extremely rare, and has a local and very irregular distribution.


M. Blackmore

BAT PORTRAITS

The serotine bat is one of our rarer bats and nearly five inches long. Notice the sharp, strong teeth which are used to bite through the hard wing-cases of beetles. Notice also the characteristic shape of the ears. The serotine bat is found in colonies hibernating in caves.

The anatomy of the bat is a study of great interest, for its alteration of its mammalian characteristics to suit an aerial existence is one of the most complete examples of secondary physiological adaptation to be found in the animal kingdom. So thorough is it, in fact, that the bones of all four limbs have been completely changed, while the thin membrane which has been developed between the greatly elongated fingers and all round the body makes the bat quite unsuited for ordinary mammalian movement on the ground.

The upper arm bone, or *humerus*, of the bat has been altered to a certain extent, and the larger forearm bone, or *radius*, still more changed; while the bones of the fingers have been changed so much from the normal mammalian formation that the inexperienced naturalist would be at a loss to identify them. The thumb is not greatly increased in size, but has been provided with a strong hook by means of which the bat can hang from any rough surface. It is over its elongated fingers that the membrane of the bat's wing is stretched, but it is also connected with the sides of the body as well as with the hind legs, as far down as the ankles. It also extends at the back beyond the legs, for it is attached to the slender tail and reaches nearly to the tip. Thus, except in the region of the head, the bat, when its wings are extended, is completely surrounded by the membrane.

The hind limbs are not exceptionally developed, but the heels are equipped with spurs, which help to support the portion of the wing membrane that extends beyond the rear of the body.

The pectoral, or breast, muscles are greatly enlarged for use in moving the wings during flight, and because of this increase in size the breast bone and the ribs have had to join together to give the muscles sufficient support. The collar bone and the *scapula*, or shoulder blade, have not undergone any great change, but the upper arm bone has been lengthened to a certain extent, while the principal lower arm bone has been elongated a great deal. The secondary lower arm bone, called the *ulna*, on the other hand, has been reduced to nothing more than a splint.

A further consideration of the anatomy of the bat shows that the vertebral column is very short. The ribs are flat and are connected, as was described above, to the breast bone, forming a strong and prominent keel. The muscles and bones of the tail control the web between the hind legs, this portion of the anatomy acting both as a rudder and elevator during flight. It is also suggested by some authorities that during flight the tail is depressed to fold the membrane between the hind legs into a form of pocket, which is used in catching and retaining the insects upon which the bat lives, though many naturalists do not believe it possible for the bat to bend itself double while in flight in order to remove (with its mouth) the insects from the pouch of membrane near the tail.

The young bat is provided with milk teeth, which are eventually dropped when maturity is reached. The adult dentition varies considerably with different species, that of the common bat or pipistrelle being:

$$i\frac{2}{3},\quad c\frac{1}{1},\quad pm\frac{2}{2},\quad m\frac{3}{3} = 34$$

In all British bats the upper surfaces of the teeth are formed into points, or "cusps," similar to those in the hedgehog (page 237), which are used to crack the hard, chitinous coverings of insects.

Sex differences are not very marked in the bat, but in some species the male tends to be larger than the female. The bat is a mammal, but unlike most mammals does not provide a lair or nest for its young. The female


G. S. Holt and M. Blackmore

FOUND NEAR WATER

This bat seen clinging to a log of wood is Daubenton's or the water bat, one of the smaller bat species. Often confused with the pipistrelle or common bat, it lives near water and feeds on the insects that hover over sheltered ponds. Its length is usually three to four inches.

J. J. Ward

BEDTIME ROUTINE

The long-eared bat is an attractive little animal that regularly goes through the practice of tucking itself in before going to bed. First (left) it tucks one ear under one wing and then the second ear under the other wing, as shown in this series of three pictures. In this manner the bat protects its immense ears during sleep and the period of its hibernation. These photographs are about half life-size.

gives birth to a single young in June or July. Before giving birth, the female bat hangs head upwards by her forelimbs and drops the young bat into the pouch of membranous skin formed by the bending forward of her tail. She then lifts the new-born bat, cleans it, and places it at her breast. The young bat clings to its mother's fur with its teeth and claws, remaining in that position for two weeks and being carried about by her during flight.

ALL bats, irrespective of species, are born blind, and are not covered with fur until seven days after birth. The young bat grows very quickly, and at the end of two weeks is too large for its mother to carry. She then takes it off her breast and hangs it up by its hind limbs in a safe place, where it is left while she is hunting for food. When she returns she replaces it at the breast. After approximately two months, when the young bat is about three-quarters full-grown, it begins to fly; needing no instruction, it instinctively flaps its wings and takes to the air.

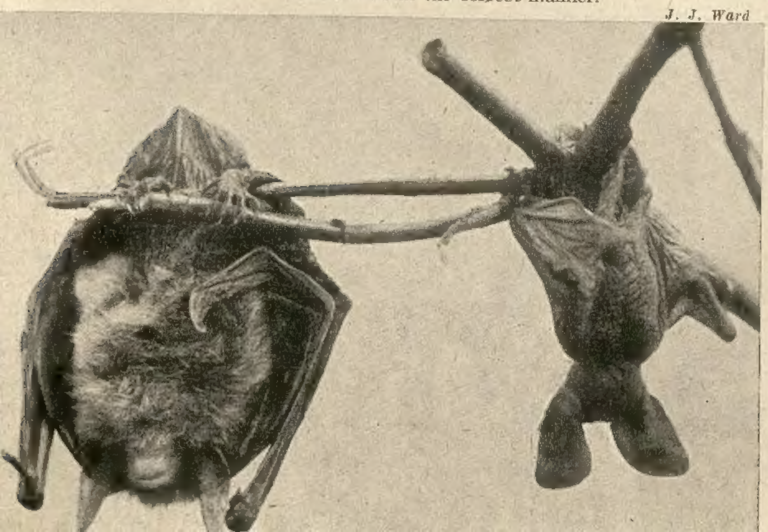
Despite popular belief, adult bats are not blind; but in most species the sight is so weak that they can merely distinguish light from darkness. On the other hand, the ears of the bat are extremely sensitive to sounds, especially highly-pitched ones. In almost all bat species the ears are greatly developed as compared with those of other mammals, and the lobes which protect the entrance to the ear orifice are often so greatly elongated as to be a very conspicuous feature, as in the long-eared bat. The shape and size of a bat's ears are an easy means of identifying the various species. The two horseshoe species are the only British bats without enlargement of the tragus.

It is doubtful if the bat can readily detect such a low sound as the human voice, but it certainly can pick up the humming noise of a flying insect from a long way off. Thus the vibrations of a gnat's wings affect the bat's ears in the same way as the drone of an aeroplane affects those of a human; consequently, the bat does its hunting for food mostly by sound attraction. It can detect the

MOTHER AND CHILD

This photograph shows a mother long-eared bat asleep with one of her young hanging a little farther along the branch. Although the latter is beginning to assert its independence by moving away from its mother, it does not seem as though it had yet learned to fold its ears in the correct manner.

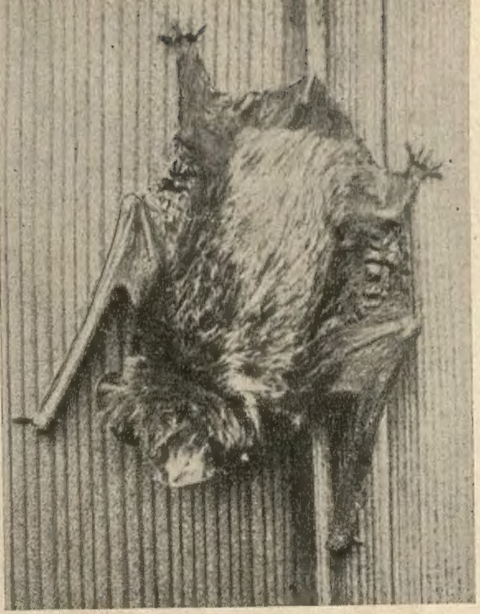
J. J. Ward



M. Blackmore

EARS ERECT

This photograph shows the great size, proportionately, of the ears of the long-eared bat. Notice the delicate "ribbing" or "veining" which is an integral part of the structure of the ear. This bat is about three inches long and is very lively and watchful.



A. R. Thompson; M. Blackmore

ASLEEP FOR THE WINTER

These three bats from left to right are the pipistrelle or common bat, the barbastelle and the whiskered bat. The pipistrelle is the commonest of our British Chiroptera, and is the small bat that is often seen flitting about at evening. The barbastelle is one of the solitary bats of medium size which may be seen flying during the early part of the evening; it is found in the southern parts of our islands. The whiskered bat is also a solitary, and in the past was frequently confused with the pipistrelle. The approximate respective lengths of these bats, from nose-tip to tail-tip, are 3 inches, 4 inches, and 3 inches, and their wing-spread 8½ inches, 10 inches, and 8½ inches.

hum of a flying insect ten feet away and immediately give chase, but it will ignore the same insect at a distance of six inches; proof of the animal's weak powers of sight and smell.

Another common fallacy is that the bat is dumb, but this is not the case, for it possesses the power of uttering a shrill squeak. If a bat is held in the hand it voices protest audibly enough, while it is not uncommon to hear bats emitting a chirping sound during flight. Sometimes, however, the bat's squeak is so highly pitched that the human ear is incapable of recording it.

British bats are insectivorous, their principal food being beetles, gnats and mosquitoes; they will eat their own weight in insect food in 24 hours. Most bats are nocturnal in their habits, and the times when they are likely to be seen in flight vary according to the different species of insects which they devour. Some bats come out at dusk and after hunting for an hour or so retire to their sleeping places until just before dawn, when they come out again. On the other hand, individual bats may be seen on the wing at all hours, and sometimes even flying in daylight.

British bats are not, strictly speaking, migratory, but sometimes they cover considerable distances. One species, the Greater Horseshoe, often changes its sleeping quarters according to the season, preferring a cave in winter and a belfry or other building in summer.

As regards their habitats, bats may be looked for in any hiding place which is sufficiently dark and secluded. Whole colonies of bats may be found sleeping at the backs of caves, while hollow trees, barns, and the eaves of old houses are also favourite living quarters. Recent experiments have established that, except in the case of females with young, bats frequently change their habitat every few days, sometimes flying between barns or eaves a mile or more apart. Moreover, even bats inhabiting one particular cave for any length of time may change their sleeping place daily. Similarly, some bats, irrespective of species, sleep in groups or clusters, while others prefer to sleep alone.

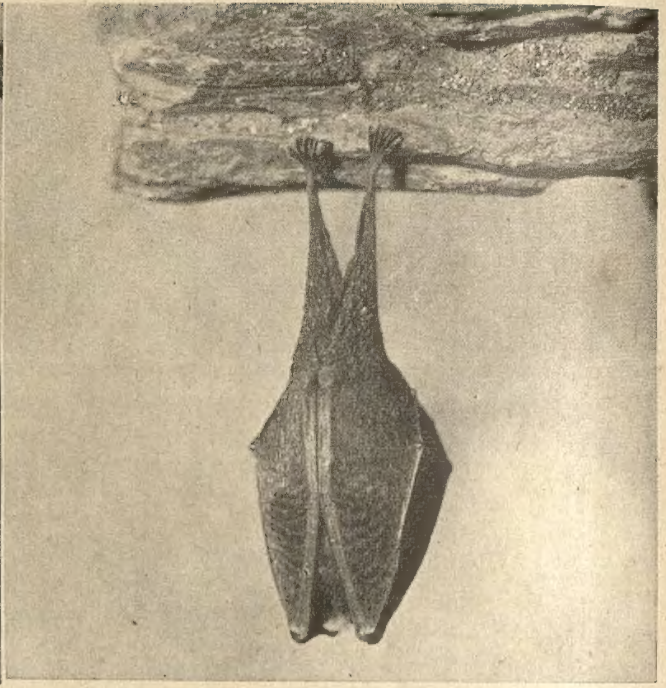
Bats are hibernating animals, and during the autumn they develop a good deal of extra fat which helps to carry them through the cold months when their insect food is scarce. But although they hibernate, bats' winter sleep is not continuous and they change their hibernating places from time to time of their own accord, particularly if the weather becomes mild. Indeed, they are sometimes seen flying outside in mid-winter.

While hibernating, bats usually huddle in clusters like a swarm of bees, but some individuals prefer to hibernate alone. The solitary hibernators generally sleep more deeply than those in clusters, probably because, lacking the mutual warmth obtained by those hibernating in tight clusters, their body temperature falls to a lower level rendering them more comatose. It has been established that the colder the winter the greater the tendency for bats to hibernate in company, although the Lesser Horseshoe bat invariably hibernates individually, even in the coldest winter. When a number of bats are clustered together in hibernation the warmth of their

OUR LARGEST BAT

The noctule is the largest of the bats found in Britain. It is about 5 inches long, and has a wing-spread of over 14 inches, though the wing is proportionately narrow owing to the shortness of the fifth finger. The fur is usually bright chestnut, but against the noctule's pleasing appearance must be set its rancid smell.

W. S. Berridge



M. Blackmore

HORSESHOE BATS AT REST

Left: Lesser horseshoe bat clinging to a branch. It normally lives in caves and is common to many of the southern counties of England. *Right:* Horseshoe bat hibernating in a cave. Thus hanging by its feet from some projection, the bat will spend the greater part of its life asleep, and during the winter months may not awake once in eight weeks. The wings are folded round the body as a means of protection.

bodies slightly raises the temperature of the surrounding air, and this appears to prevent their sleeping very soundly.

Bats make tractable pets if carefully treated, but they are delicate in health, and attempts to keep them in captivity usually fail through lack of proper food. They should be fed on mealworms, small moths, beetles and other insects, together with plenty of water. They should not be given milk as this injures their liver. On very rare occasions, bats have been bred in captivity, but captive bats seldom live much longer than a year, against their average life-span of 40 years in a wild state.

Various theories have been advanced to account for the bat's ability to avoid colliding with obstacles while flying in pitch darkness. One of the earliest experiments made in an attempt to solve this problem was carried out in the eighteenth century by the Abbé Spallanzani, an Italian naturalist. He deprived a bat of sight by covering its eyes with wax and also rendered it unable to smell and hear; then he released it in order to observe its behaviour in this state of deprivation. It was found that the bat was capable of flying about a room across which a number of threads had been crossed without hitting one of them.

For many years it was generally accepted that the bat's ability to avoid obstacles in the dark was due to the animal's wing membranes and hairs on its muzzle being so sensitive that they gave it an indication of the very slight increase in pressure and temperature which would result from its rapid approach to any object in its path. Other observers have suggested that the bat's eyes are sensitive to radiations, such as the infra-red rays, unseen by man. The fact that Spallanzani covered his bat's eyes would seem to rule out this theory, but it has been pointed out that infra-red rays can penetrate wax.

Later experiments by Professor Griffin and Doctor Galambos, two American naturalists and scientists, have definitely established, however, that the bats' sensitiveness to unseen obstacles is due not to perception of increased pressure or sensitiveness to radiations, but to the animals', having an extra sense, very similar to radar in principle. By means of a microphone used in conjunction with an amplifier and a cathode ray oscillograph, it has been found that the bat in flight emits a rapid succession of high-pitched squeaks or "pulses," having a frequency of between 25,000 and 70,000 cycles a second, which are thus inaudible to the human ear.

While flying on a course without any obstacles, the bat utters some 30 squeaks a second, but as an obstacle is approached, the squeaks increase to as many as 60 a second. These squeaks or pulses are reflected by walls or even threads back to the bat's ears, so enabling it to take the necessary "avoiding" action. The time lapse between the emission of the squeak and its reflection back to the animal occupies a small fraction of a second. It has been further established by electronic measuring instruments that the bat's supersonic squeaks are emitted as a narrow beam of sound through the animal's complex nasal structure.

Bats appear to rely entirely on their "radar" system when coming to rest after flight, as they invariably land head uppermost after skimming close to the wall or other surface on which they alight. There is little, if any slackening of speed before landing, and they rarely miss their hold, even in the darkest cave.